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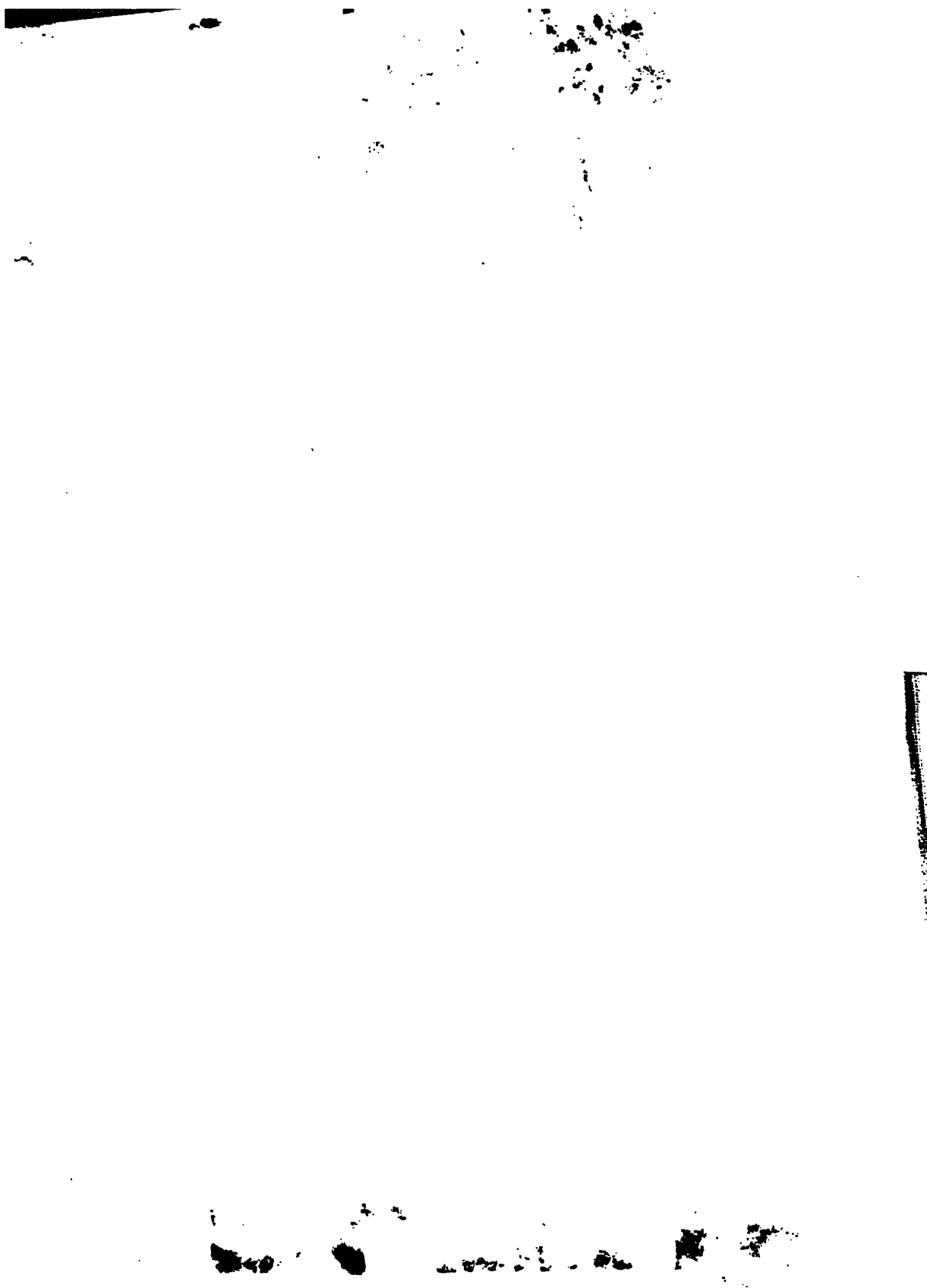
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THIRD EDITION.

THE
GOLD MINES
OF THE WORLD

J. H. CURLE





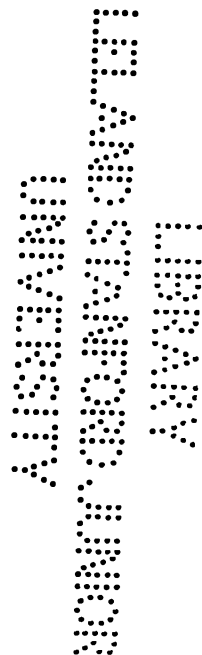
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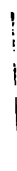


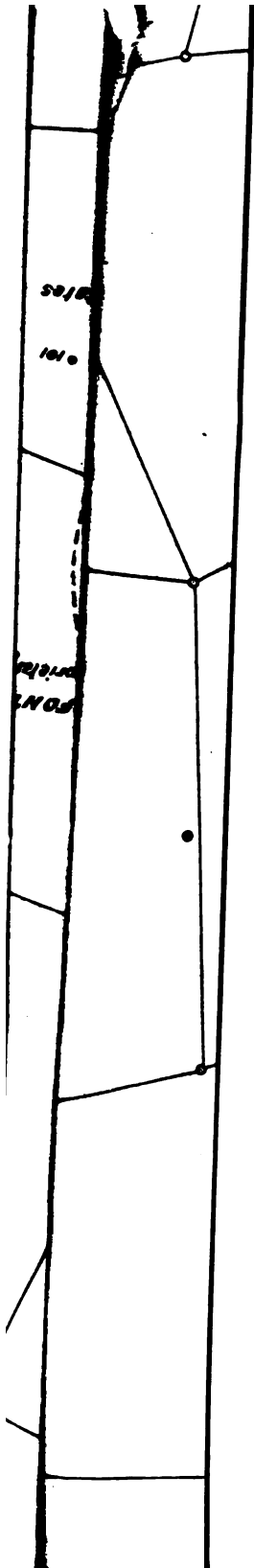
THE GOLD MINES OF THE WORLD



THE second edition of this book was published by Messrs. Waterlow and Sons, Ltd., in 1902. The present edition has been re-set throughout, and almost entirely re-written.

October 1905.
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List of Boreholes already sunk in East Rand Basin.

● Those showing a value of more than 30/- per ton over 36 inches.

● Those showing a value of less than 30/- per ton over 36 inches. (Where no figures are given the results may be considered as unpayable.)

No. of Hole	Owner of Ground.	Depth of Reef – feet	Width of Reef – inches	Value per ton – shillings	Remarks
1	Apex Mines	937			
2	„	1227			
3	„	1368	5	40	
4	„	2456	26	36	
5	„	2381	36	8	
6	„	1517			
7	„				
8	„	160			
9	„				
10	„				
11	„				behind reef
12	„				behind reef
13	„				abandoned
14	„	1467			
15	„	228			
16	„	773			
17	„				
18	„				
19	„	247			
20	„	964			
21	„				
22	„				
23	„				

No. of Hole	Owner of Ground.	Depth of Reef feet	Width of Reef - inches	Value per ton - shillings	Remarks
24	Apex Mines	2833	24	61	estimated true depth--2550 feet
25	Benoni	612	8	74	
26	"	387	78	13	
27	"	157			
28	Chimes West	477	15		
29	"	227	24		
30	New Kleinfontein	778	18 10	57 51	reef sections 4 feet apart
31	Van Ryn Deep	1754	36	67	
32	"	1545	36	39	
33	"	2319	3	95	
34	Modderfontein Deep	2967	80	25	Mixed stringers of ore and quartzite
35	"	2803	12	65	
36	"				disturbed ground, no ore
37	Brakpan Mines	2617	3	154	some core ground away
38	"	4470	36	27	estimated depth on re-survey 3360 feet
39	"	4419	11	8	some core ground away-estimated depth on re-survey, 3410 ft.
40	"				disturbed ground--no ore
41	"	4578	26	27	estimated depth on re-survey, 3380 feet
42	Van Dyk Propy.	1967	11	9	
43	"	1473	5	22	
44	"	2129	32	1	
45	"	2301	31	72	
46	"	1554	35	169	
47	Rand Collieries Ltd.	2215	29	191	
48	"	3783	64	48	
49	Modderfontein Exn.	630			
50	"	273			
51	"	612			
52	"	518			
53	"	923			
54	North Geduld	1390	6	138	
55	Central Geduld	1716	10	431	

No. of Hole	Owner of Ground.	Depth of Reef—feet	Width of Reef—inches	Value per ton—shillings	Remarks
56	Geduld	2135	14	72	
57	Cloverfield Mines	1979	17	131	
58	"	2990	4	84	
59	Rand Klipfontein				
60	"	239			
61	"	904	6	46	
62	"	463			
63	"	175			
64	"				
65	"				
66	"	378			
67	"				
68	"				
69	"	393			
70	"				
71	"	1940	33	26	
72	"	1290	4	21	
73	"	1889	35	44	
74	Klipfontein Est.		38	8	
75	"				
76	"	918			
77	"				
78	Trans. Con. Lands				
79	"	988			
80	"	605			
81	"	706			
82	"	781			
83	"				stopped in dyke at 2004 feet.
84	"				behind reef
85	"				"
86	Welgedacht	2723			poor
87	"	2842			"
88	"	3096			"

No. of Hole	Owner of Ground.	Depth of Reef— feet	Width of Reef— inches	Value per ton— shillings	Remarks
89	Welgedacht				poor
90	"	2385			"
91	"	1908	10	85	
92	Lace Proprietary	1171			
93	"	1351			
94	"	1500			
95	"				
96	Grootvlei Synd.	3414	21	25	
97	"	4300			
98	"	2376	7	8	
99	E. R. Mg. Estates	3085	21		
100	"				stopped in dyke at 1350 feet
101	"				behind reef
102	"				"
103	E. Expln. Co.	3478	18	121	
104	"	3617	11	91	
105	Cassel Colliery	5540			true depth, on re- survey, 4880 feet
106	Daggafontein				
107	"	3276	5	84	
108	"	2118			
109	Lydenburg Gold Farms	860	5	63	
110	"	441			
111	"				behind reef
112	"				
113	"				behind reef
114	Cond. G. F. of S. A.				stopped at 3000
115	Marievale Nigel				nine holes sunk here, all were poor
116	Henderson Nigel	1480	9	8	
117	Sub-Nigel				
118	"	548			
119	"	537			
120	Mines & Minerals	549	31	120	accuracy of figures doubtful
121	"	435	12	120	accuracy of figures doubtful

THE GOLD MINES OF THE WORLD

THIRD EDITION

(REVISED AND EXTENDED IN SCOPE)

WRITTEN AFTER AN INSPECTION OF NEARLY FIVE HUNDRED MINES IN TRANSVAAL, RHODESIA, WEST AUSTRALIA, VICTORIA, NEW SOUTH WALES, QUEENSLAND, TASMANIA, NEW ZEALAND, INDIA, MALAY PENINSULA, SIBERIA, UNITED STATES, ALASKA, KLONDYKE, BRITISH COLUMBIA, MEXICO, PERU, BRAZIL, SUDAN, HUNGARY, BOHEMIA, AND WALES

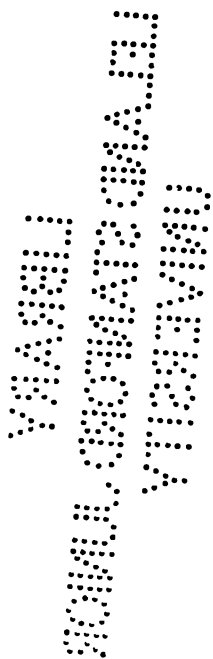
By J. H. CURLE

WITH PLANS AND PHOTOGRAPHS



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THE GOLD MINES OF THE WORLD

CHAPTER I

SOURCES OF THE GOLD SUPPLY

THE world's yield of gold for 1904 is roughly estimated to have been about £71,500,000, the highest yield on record.

This may be broadly summarized as follows :—

From North America	.	.	.	£ 23,500,000
„ Africa	.	.	.	18,000,000
„ Australasia	.	.	.	18,000,000
„ Asia	.	.	.	8,500,000
„ South America	.	.	.	2,500,000
„ Europe	.	.	.	1,000,000
				<u>£71,500,000</u>

Reckoning the yield by countries, the largest producers were :—¹

Australasia	.	.	.	£ 17,928,000
United States and Alaska	.	.	.	17,380,000
Transvaal	.	.	.	16,054,000
Russian Empire	.	.	.	4,624,000
Canada	.	.	.	3,371,000
India	.	.	.	2,386,000
Mexico	.	.	.	2,197,000
Rhodesia	.	.	.	1,030,000

¹ Estimated results.

Of the total yield, the English-speaking peoples were responsible for about £63,000,000, or, say, 88 per cent, much the greater part of this being produced in their own territories. Indeed, they may be said to show as marked a bias towards pioneering, of which gold-mining is a branch, as the Germans towards music, or the Chinese to husbandry. It is not, however, correct to assume that the English-speaking countries contain more gold than other countries. Gold is one of the most widely distributed metals, and if the rest of the world were to put the energy and the capital into gold-mining that the English-speaking peoples do, the discrepancy in production would be much less than it is now. So far as I am able to judge, such countries as Russia, Siberia, China, Korea, the Dutch Indies, and Central and South America ought to produce far more gold than they do; but it seems more than likely that the rest of the world will not take up the big and costly work of systematically exploring these countries for gold, and that on the English-speaking peoples, following up this favourite pursuit of theirs, will fall the greater part of the needed development.

A more important division of the world's output of gold, so far as we are concerned, is that produced by British capital, as compared with the production from all other countries combined.

First, let us take the British Empire's production in 1904, which was :—¹

	£	
West Australia . . .	8,424,000	
Victoria . . .	3,252,000	
Queensland . . .	2,715,000	
New Zealand . . .	1,987,000	
New South Wales . .	1,146,000	
Tasmania . . .	280,000	
South Australia . .	124,000	
	<hr/>	
	Australasia . .	£17,928,000

¹ Estimated results.

Transvaal	16,054,000		
Rhodesia	1,030,000		
West Coast	350,000		
Egypt and Sudan	25,000		
	<hr/>	Africa	£ 17,459,000
Yukon	2,100,000		
British Columbia	1,181,000		
Nova Scotia	40,000		
Newfoundland	30,000		
Ontario	20,000		
British Guiana	329,000		
	<hr/>	America	£ 3,700,000
India	2,386,000		
British Borneo	150,000		
Malay Peninsula	80,000		
	<hr/>	Asia	£ 2,616,000
Wales	70,000		
	<hr/>	Europe	£ 70,000
Production of British Empire			£ 41,773,000
To this add the output from foreign mines controlled by British capital, estimated at, say			£ 3,227,000
Total controlled by British capital			<hr/> £ 45,000,000 <hr/>

The British Empire, therefore, in 1904 produced 58 per cent, and British capital controlled 63 per cent of the world's yield of gold. Against this has to be noted the fact that foreigners, mainly French and German, hold a large interest in many of our best mines. We continue to control such mines, but our national participation in their profits is by no means so great as I should like it to be.

At £71,000,000 I do not consider the world's yearly output of gold has reached high-water mark, and five years hence it promises to be nearer £90,000,000. But it must not be assumed that

the output will increase indefinitely; the five-yearly period after that is, to my mind, just as likely to show a falling off as an increase.

The chief factor for the next few years will be a largely increasing yield from the Transvaal. That country's yield, which in 1904 was £16,000,000, should in the course of five years reach any figure from £30,000,000 to £40,000,000 annually; after that any further increase could not be looked for with equal certainty.

One cannot look five years ahead in other countries with a like degree of exactitude; but on present knowledge it would be justifiable to expect a falling off in the gold yield in a number of places. Many of the principal gold-fields, which for years past have been the mainstay of their respective countries, seem to me to have passed their zenith. I include among these: Cripple Creek (Colorado), Klondyke and Rossland (Western Canada), Kolar (India), Charters Towers and Gympie (Queensland), Bendigo (Victoria), Ohinemuri (New Zealand), and Kalgoorlie (West Australia). Of course, it is not to be assumed that in five years these fields will be exhausted, or that individual mines will have come to an end; but there is good reason to think that most of these fields have seen their best days, and that in five years they will not be producing, in the aggregate, nearly so much gold as they do now.

As against these probably declining centres of production, there should be a gradual increase from such countries as Rhodesia, West Africa, Egypt and Sudan, India (other than the Kolar district), Dutch Indies, Korea, Japan, China, Russian Empire, Alaska, South Dakota, Nevada, Mexico, Central America, British Guiana, and Bolivia. These rising producers may make good the loss elsewhere; but it is to be noted that on balance, always excepting the big increase in the Transvaal, the prospect for the British Empire do not look too good, and we must take



FIXING A ROCK DRILL—MERCUR MINE, UTAH

our capital shall control the usual proportion of mines in these newer foreign fields.

There is one factor which tends more and more to a general increase in the gold yield—that is, the coming into the payable horizon of all sorts of low-grade ores, which in former years were looked on as not profitable, but which now, owing to some one or other improvement in method, can be made to pay. All over the world ore deposits are being worked, or are being secured with a view to eventual working, which ten years ago engineers would not have bothered their heads over, and one is fairly safe in assuming that finality in this direction has not yet been reached. Consider, notably, under this head the rapidly increasing yield from dredging. In 1904 dredges returned about a million pounds, and many yielded good profits. All of this was from ground which the miner of ten years ago would not have looked at, and more than half came from ground which even five years ago could not have been handled to pay. The varied deposits of very low-grade gold-bearing material in the world, many of them of immense size, and their present relation to the most advanced methods of treatment, is a fascinating subject for inquiry.

Some idea of the trend of the world's gold output can be got by summarizing all the work going on at present.

In the Transvaal, as I have said, a largely increasing yield is a certainty. This will mostly come from the Witwatersrand; it is quite possible that at its zenith the yearly output from this field will exceed £40,000,000. The continuation of the conglomerate beds worked on the Rand is being traced over a large area of the Southern Transvaal and Northern part of the Orange River Colony. Most of this ground is found to be very poor; but the day is coming when patches here and there will be worked at a profit, and a large industry, supplementary to the Rand, will, in course of time, come into being.

The gold-ore deposits of the Transvaal, other than conglomerate, cut no great figure. I would pick out the Lydenburg field as the most promising of these. There is much talk about the prospects of Barberton, the Murchison, Letaba, Malmani, and other places; but I could not lay my finger on any mine in these latter districts which is in an assured position.

In Rhodesia the output of gold will go on increasing for a year or two—that is, on known data. It should reach £2,000,000 a year; but I would not assume that it can be kept up to this. The Rhodesian mines are mostly very small, and have so far been the reverse of profitable. In the country's favour one must note its great area, the widespread distribution of gold, and the lavish expenditure on railways to new mining districts.

In Cape Colony, Natal, and German West Africa there is as yet no gold output to speak of.

The Orange River Colony carries the extensions of the conglomerate beds. These so far have not been found payable, but they are worth, and will no doubt receive, further prospecting. Mozambique has gold, especially in the Manica district, but it is unhealthy, and is still hanging fire. No doubt at some future time this country will receive more attention.

Central Africa contributes no gold to the world; but prospectors have located reefs in German East Africa, and a little alluvial gold comes now from the Congo.

British West Africa is become a considerable producer, and no doubt the mineralized belt that is being exploited in the Gold Coast and Ashanti extends over a still bigger area. Personally I have no use for this country, with its deadly climate, but there is no doubt it carries gold, and its yield will go up in the near future.

Madagascar produces some alluvial gold, but its future as a reef-mining field is uncertain.

The Egyptian gold-belt, lying between the Nile and the Red Sea, extends down into the Sudan, and from there on into Abyssinia. This is interesting because it is new, because the field is so immense in area, and because there are widespread remains of ancient workings. So far the results of development have been of doubtful value. The yield will increase, and there is room for a lot of exploratory work, but there is nothing as yet to draw the attention of practical people.

Turning to Australasia, it may be stated in general terms that the output of gold during the next few years seems more likely to decrease than to increase. West Australia, the biggest producer, is at present on the down grade. In 1904 the yield fell off, and the fall in 1905 will be still more. The strain of keeping up to the large output of the past falls now mainly on the few big mines; but as quite half of these have no very assured future, it is most unlikely that they will be able to come to the rescue. The gold-field in this state is so vast that many more discoveries must be expected; but it may be that the figures of 1903 will never be reached again.

In Queensland, too, a serious falling-off is foreshadowed, and I look for declining outputs for the next year or two. Here again you have an immense gold-field, and there ought to have been far more new discoveries during the last ten years than there have been. It seems to me that systematic prospecting of its gold resources will be a question which the Queensland Government must look into before long.

Victoria is the ideal country of the small, profitable gold-mine. There are no big mines there, but many hundreds of small ventures, and an unusually large proportion of these are successful. Considering the great amount of gold produced by Victoria since 1850—a matter of £270,000,000—one is fearful that the limit must be reached, and that there will soon be no more left. I thought that six years ago; but the output to-day is bigger than it was then, and the immediate outlook is quite good. The completion of the drain-

ing of the deep leads, too—which seems imminent—is likely to see a big increase in the yield from this type of mine. The mainstay of Victoria is the Bendigo field. It is not in reason to expect that that centre can maintain its yield for many years more, but just at present it is doing quite well.

New South Wales has at present only one gold-mine of any size, which, considering its area and its antecedents, is surprising. Its output is made up from numerous small mines, from dredges, and from the subsidiary gold yield of some of the copper-mines.

South Australia is insignificant for its gold. Its two lately discovered fields are far inland, and as yet disappointing; while the yield from the Northern Territories is also too small to be of any immediate importance.

Tasmania has seemingly only two mines that will stand working. Both have been very profitable, and the yield of one will increase. The balance of the output comes as a by-product from the copper-mines.

New Zealand has one large gold-mine, two or three third-rate producers, and a lot of small deposits of no real importance. The dredging industry continues to do well, but the most profitable sands are limited in extent. Speaking generally, I should say the output of New Zealand will fall off in the near future.

New Guinea cannot yet be counted on as a serious producer.

In Asia the outstanding producer is the Kolar field, in Mysore. This field seems to me to have reached, or perhaps to have passed, its zenith. The prospects of several gold-fields in Hyderabad and in the south of Bombay are rather hopeful, but it will be some years yet before one can speak with much certainty as to these. In Burmah there is no reef mining, but some dredges are in course erection.

In the Malay Peninsula one is again among small mines, and their history has abruptly ended at anything below 100 feet. A dredge in the State of Kelantan has shown fair results, which may lead to a local extension of this industry.

In Siam there is no reef mining, nor in the French colonies; Borneo is a moderate producer, but the climate is against this field.

In the Dutch Indies, notable Sumatra and the Celebes, there is the making of an industry. One mine in Sumatra is important, and others in the same island are said to have possibilities above the average. The local methods of control are unsatisfactory.

As to China we know surprisingly little, and that little is unfavourable. The estimate published by American authorities of an annual yield of £1,500,000 sterling, seems to me an excessive figure. I know of only one good gold-mine in China, and as that is worked by primitive methods on a small scale, it does not materially assist the output. As to Manchuria, one hears tales of rich reefs and alluvials, but my inquiries on the spot did not bear this out.

The neighbouring Korea is a much more advanced gold-field, and some big low-grade deposits of great promise have been developed. An American company is working several hundred stamps on its mines, and has an assured future. This country will receive a lot of attention in the next few years.

Japan has only a small output of gold, and the most recent visits there of engineers have led to disappointing conclusions. As yet mining in Japan is not in the hands of foreigners.

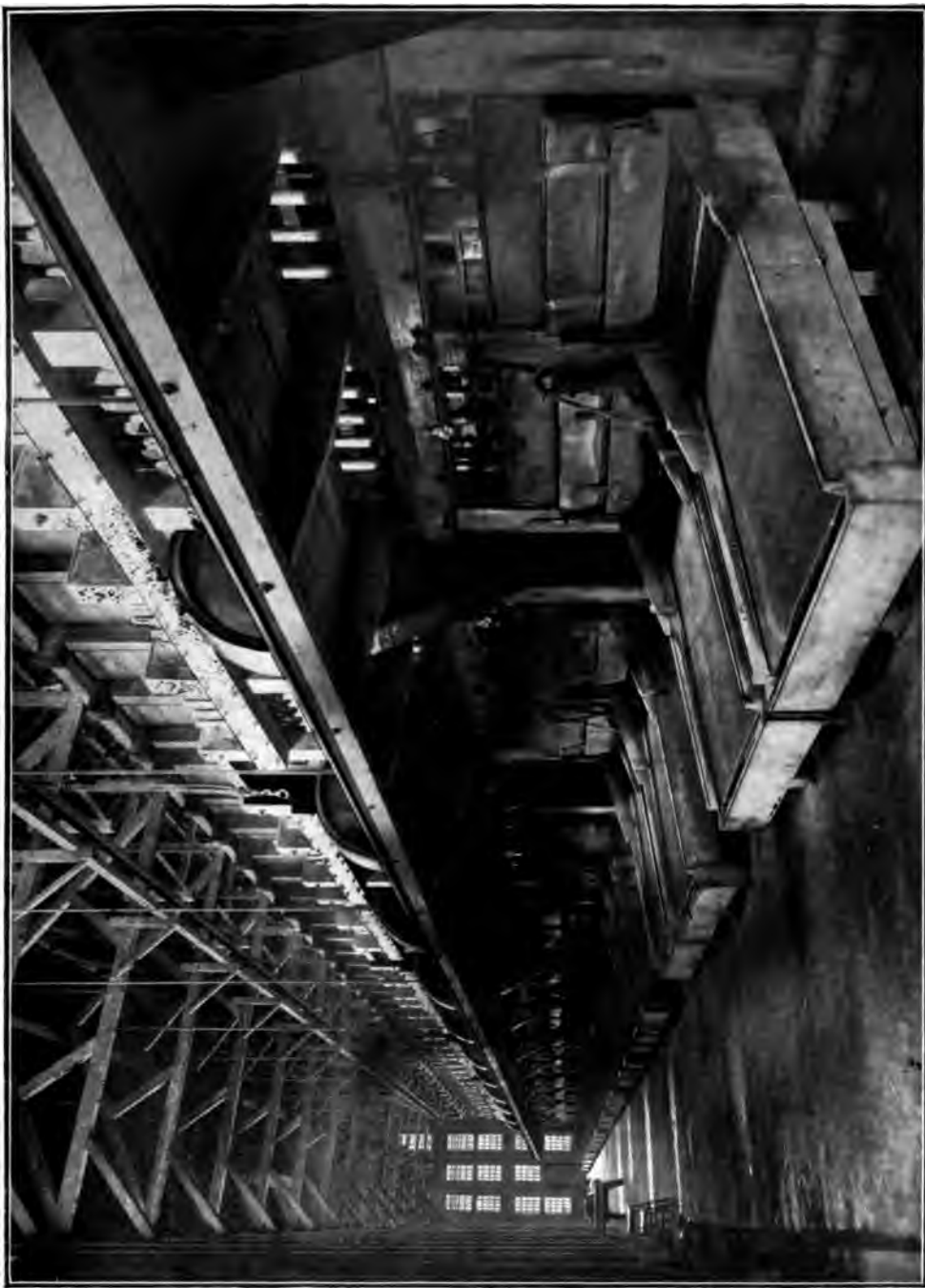
In the Russian Empire there has been gold-mining for 130 years. Nearly all the large output is gained from alluvial beds, and as these become worked out the centre of gravity tends to shift farther and farther east. The day is coming when the richer gravels will

be exhausted ; but by that time I expect to see the undoubtedly big possibilities of reef mining subjected to scientific exploration and development. In many ways present conditions in Russia and Siberia are not satisfactory, but I have no doubts as to the existence of lots of gold. I can conceive the time when Siberia will have become an international gold-field, with an output commensurate with its great size.

In Europe the only producer of note is Hungary, with an annual output approaching half a million. This is a country of small mines, with the exception of a German company working 185 stamps. In Bohemia there is one small gold-mine, and there is a producing mine in Wales ; but the yield of Sweden, Norway, Germany, Spain, Portugal, Italy, and Turkey, is at present so small as not to be worth noticing.

In America, beginning in the far north with Klondyke, it may be said that the yield from that field has been declining for some years and will probably continue to decline. There is plenty of gold still there in the gravels, but this is as a rule not extractable at a profit except by hydraulicing, which the short supply of water does not admit of. Klondyke is now a centre for other alluvial fields, which wax and wane from season to season ; but on the whole the tendency of the Yukon territory at present is towards a lower output. The alluvial field of Atlin, in Northern British Columbia, has not as yet fulfilled the promise of some years ago ; nor have the big gravel areas in the Cariboo district. The Rossland field has now yielded up its richest ore, and the mines there, with big working costs on the one hand and low-grade ores on the other, are doing little more than marking time. The smaller gold-mines of the country are mostly shut down.

In Ontario the output of gold has now fallen almost to nothing ; the Lake of the Woods district, from which so much was a few years back, is a dead field.



BATTERY OF ALASKA MEXICAN COMPANY, DOUGLAS ISLAND

In Nova Scotia the yield for 1902 was the lowest for some time, and a small improvement may come about this year, but the State does not take serious rank for its gold. The small gold yield of Newfoundland comes from its copper-mines.

This record of Canada is most disappointing, and big discoveries are needed to neutralize the falling off in all districts. It can hardly be said that there is a payable lode gold-mine in the whole of Canada at present, certainly not one where the future is on an assured basis.

In Alaska the output is going up, and the placer diggings of Nome, Fairbanks, Koyukuk, and Good Hope appear to be in a more hopeful condition than those on the Canadian side of the boundary line. The big ore-bodies on Douglas Island continue to look well in depth, and have assured prospects. The spot in Alaska on which my attention is most keenly focussed is the mainland over against Douglas Island. I am convinced that these enormous ore-bodies of the Silver Bow basin have the making of one of the big low-grade mining-fields in the world. Capital in abundance is required for the mines, but it seems to me that the expenditure is justified.

In the United States Colorado continues to be the principal gold-producing State, but I believe its big gold centre, Cripple Creek, cannot long continue to produce as in the past. The ore-bodies on this field, like so many ore-bodies elsewhere, are found to lose their value with depth, and the mines do not tend to get shallower as the years pass. The mines of the San Juan and Boulder districts are doing well, but hardly give evidence of making up for the probable falling off at Cripple Creek.

In California, which equally with Victoria is the ideal gold-mining country, the output has increased lately, and the dredging industry there is making great strides. There are no large producers in California, but a host of small mines, backed by a number

of skilled engineers, and no doubt the output of gold will continue for many years to come.

South Dakota is a State whose possibilities attract me. Besides containing the biggest gold-mine in the world, it has, in the Black Hills, a district of which I expect much. The Black Hills ore-bodies are quite low-grade, but many of them are of gigantic proportion, and their amenability to cyanide is a strong point.

The rise of Nevada, in the last three years, as a gold-producing State, is to be noted. This is due to the discovery of the new fields of Tonopah and Goldfield. Tonopah is not by rights a gold-mining camp, for the ores carry more value in silver; but the gold values are substantial nevertheless.

Utah, Arizona, New Mexico, and Idaho maintain a considerable gold yield in the aggregate, but do not call for particular notice, while all the other States, from a gold-mining point of view, may be described as unimportant.

Mexico has largely increased its yield of gold in late years, and will no doubt improve for a year or two yet. There is a general impression that this is one of the coming countries of the world as regards gold. This year, or next, several rich mines will commence to produce largely, but as against that several of the best mines are not just now looking well in depth. On the whole, I can see an increase for a year or two ahead, but feel less certain with regard to a more remote period.

Central America tends to go better. This is, as a rule, not a healthy region, but it is not among the worst; I am inclined to think English capital might meet with some success here.

Taking South America as a whole, it is surprising to find such an immense territory producing so little gold. The reason cannot be that there is an inherent scarcity of the metal. The great Andean

range, explored mainly on its western slopes, has yielded fine deposits of silver, copper, and tin, but remarkably little gold. It is my belief, mainly empirical perhaps, but partly borne out by observations in Peru, and by a study of this question, that the eastern slopes will be found to carry the gold; but as yet the eastern slopes of the Andes in Ecuador, Peru, Brazil, Bolivia, and the Argentine are, to a great extent, a terra incognita, and likely, for all the amount of exploration going on, to remain so.

Here is a great chance for us. Why should we not start in and explore these districts, and get hold of the cream of what there is in South America? The Rand is a great field, heaven knows! but it need not take all our energies and use up all our capital. I am in favour of making a big effort to get at the secret of these Eastern Andean slopes.

The list of notable gold-mines in South America is a short one. The best of all is, perhaps, a mine that was lately found in British Guiana, and there is one in Brazil. Peru is disappointing of late, and Venezuela. Columbia recently has suffered the effects of peculiarly atrocious government. Ecuador has never produced much gold, nor Paraguay, nor Chili, nor Bolivia, nor Uruguay, nor Argentina; but I believe most of the States will be all right when developed. If the interior of the Guianas were more healthy it is a district which would commend itself, and even now the alluvial yield of these countries is considerable. Brazil is the largest producer in South America, but we have not made much out of it.

In the mind of the layman there is apt to be confusion between the existence of gold—than which there is no more widely distributed metal—and its presence in payable quantity. To such people, for example, the presence on any field of ancient workings is evidence of assured value. The inexperienced man argues thus: "If the ancients with their crude methods could work this mine at a profit, machinery and modern methods will extract a still greater

profit." The experienced man, on the contrary, would state the case in this way: "There is no evidence that ancient workings denote the location of a payable mine. It is probable that these were made by slave labour; that the small cost of feeding the slaves was the only item of expense; that practically all the gold extracted was profit to the owner; and that such a condition of affairs cannot be compared with modern economic conditions." This argument is undoubtedly correct. It can almost be proved by evidence; for if ore immediately adjacent to ancient workings is sampled it will as often as not be found to be unpayable. The evidence will also show that many ancient workings, even if they were rich in gold, deal with such relatively small patches of ore, that under modern conditions, entailing the erection of an expensive plant, they would be bound to fail. That, at least, is my own experience. After examining old workings in India, Pahang, Sudan, Rhodesia, Peru, Hungary, and Bohemia, and sampling some of these, I must record my belief that a great deal of the ore worked by the ancients was what we would call unpayable, and that the presence of old workings is the poorest sort of evidence on which to foretell the success of a gold-mine.

So much for the gold-fields of the world. Just one more field must be mentioned, one which has been in the public eye a good deal lately. That is the Sea! There is, of course, gold in solution in sea-water. This is nothing new, for repeated attempts have been made for many years to treat it at a profit. An eminent chemist wrote a report in 1904, making therein the statement that he had inspected a process which had been able to precipitate the gold, and he inferred that it might be possible to do this on a commercial scale. His assumption was based on a gold contents of nearly 2d. to the ton of water. It is possible that certain parts of the sea hold this amount of gold in solution; I believe, however, that it is more correct to assume that on an average there is not more than one-tenth of a penny to the ton of water, of which only part could be recovered by precipitation, and it seems most unlikely

—on such figures—that any process, even if it did precipitate some of the gold, could earn a profit. The profitable recovery of gold from sea-water, if the secret could be kept, would make its owners horribly rich, and if the secret were not kept would disorganize the financial basis of the world. But I venture to doubt the supposed quantity of gold in the water of the sea, and to assume that it will not be extracted at a profit in our time.

CHAPTER II

BRITAIN'S POSITION IN GOLD-MINING

FROM the figures already given we see that the empire, and Britain in particular, holds a preponderating position in an industry which adds over £70,000,000 a year to the wealth of the world.

But this is not all; for with our natural bias towards gold-mining, our organization in this direction, and our capital available for systematic exploration and development, we are in a position greatly to increase our hold on the industry—and are doing so all the time.

Gold-mining is in reality one of our biggest national assets, mentally and materially. The getting of the gold fosters such virtues as energy, self-reliance, victory over physical drawbacks, and the spirit of exploration in the unknown and difficult parts of the world, while its possession brings to us wealth and power—the gods most assiduously worshipped by mankind. This is the argument of materialism, no doubt; but it is not the use, but the abuse of wealth and power which matters, and if the British can increase their control of the world's output of gold without a corresponding loss in the national character, there is every reason for them to do so. We are, I believe, all cranks on some one point—my own, I frankly admit, is gold-mining; so while others devote their energies to a greater efficiency in the army, or to a stronger navy, or to better postal facilities, or to cotton-growing in the colonies, or to foreign missions, I as willingly dedicate my work to the state of our gold-mining industry.



MINING IN THE ROCKY MOUNTAINS IN WINTER

Mining in its several branches is an industry more advanced and better handled in the United States than in the British Empire. We do not get, relatively, from our gold industry what the Americans do from their copper, lead, or iron, and the comparison could be carried further.

At the root of the question is the personal factor. In America, engineering—mining engineering perhaps especially—is an honoured profession, and attracts to its ranks men of the best birth, of strong character, and of exceptional brain-power. In England, on the other hand, we are dominated by the caste system, and caste declares that an engineer is to rank far down in the social hierarchy. An engineer in America is as good as any other man, and if his abilities entitle him to do so, can rank with the best. In England things are different; brains carry some weight, but not so much as social position, and the intellectual profession of engineer ranks distinctly lower in the social scale than, for example, the less intellectual profession of army officer or episcopal parson. An upper-class father in Britain might encourage a son to go into the Army, or the Navy, or the Church, or to study for the Bar, or to farm in the colonies, but it would never occur to him to make his son a mining engineer; and if any one happened to suggest such a calling, its social aspect would weigh heavily against it in the eyes of both father and mother.

Of course, to one who realizes what qualities are called for in the ideal mining engineer, the whole thing appears ridiculous. England might well give of her best to this profession, and upper-class families be proud to have a member in it. Such a time will come, no doubt, but at present it has to be said that caste has won the day, that our best blood and brains are not sufficiently represented in mining engineering, and that most of the responsible and highly paid posts in our own gold-mines are, as a natural consequence, held by Americans.

The next point is education. Here our would-be mining engineer finds himself at a serious disadvantage. In the United States there are at least three universities—one in New York and two in California—which turn out highly educated mining engineers, but in Britain there is not one. With our great national stake in gold-mining, why should it not be possible to take the degree of mining engineer at Oxford, or Cambridge, or London? When I was at Cambridge, I took a course of study which it was supposed would be of assistance to me in mining, but a course in Chinese or Hebrew, with the same object in view, would have borne just the same results, and would have been less mentally confusing. It is the old story over again. Engineering has not been considered a proper profession in England socially, and although, with the advance of education a change is bound to take place, the powers that be have not yet realized this.

There is a School of Mines in London, it is true, and within its sphere of influence it does what it can. But it carries insufficient prestige, and does not give the splendid training that the American universities do. The London School of Mines will not take its proper position, either separately, or as part of a technical university, until it receives as good a type of man as the American universities, and until the degree of mining engineer shall be highly valued, and shall carry the social and intellectual prestige it carries in America.

The average young Englishman who takes up mining as a profession does not at all come up to the mental standard one wants to see. As a rule, even if a School of Mines man, he seems contented to become an assayer, or surveyor, or to have control of the mill, or the cyanide plant. He gives one the impression of lack of confidence in himself, and of tacitly admitting that the position of general manager is too big for him to aspire to. He is too often willing to keep up-to-date only in his own branch of work, and let all the rest of his knowledge run to seed.



ANCIENT CRUSHING MILLS, SUDAN

Here again we show to disadvantage, for the young American in the same position has a personality and an active brain, is in touch with every branch of the mine's work, and is ready to assume the management at a moment's notice. Of course this is largely the result of the finer scientific education he has received, and our own men would no doubt show to similar advantage with the same opportunities ; but the present state of things is as I have described.

As showing the way the young Englishman sets to work to make a career for himself in mining, I will give an extract from a letter I received last year from a young School of Mines man for whom I had got a post in West Australia. It runs :—

“I stayed one day in Perth, and then came straight through to this place, which so far has struck me as being rather a terrible hole. When I saw Mr. —, he said I should have to work underground, which was rather unexpected, as I thought I was coming out here to be an assistant in the assaying or surveying department. Another blow is that I am getting £3 a week instead of the £3 10s. Mr. — said I should get. . . . I must say the underground work will give me a great deal of experience and do me no end of good. The only thing that I object to is that when I left England I wasn't under the impression I should have to work like a miner.”

The youth was no doubt unaware that not only I, but the General Manager of the mine in question, had commenced by working as a miner, and at a less wage than £3 per week. Furthermore, he will understand one day that underground work, where you can keep your eye on the ore, on which the whole of the mine depends, is a directer road to promotion than being side-tracked into the assay office. But why didn't his School of Mines training teach him this ?

The caste system lays it down that it is not correct for a man of high birth to become a mining engineer, or the manager of a mine,

where perhaps a thousand men do his bidding. On the other hand, it is considered quite the right thing to be the director of a mine, even if you are merely a dummy put in by a company promoter, and have got to do as he tells you. It has come about, therefore, that lords, or other titled people, retired generals, civil servants, and the like, have crowded thickly on to the boards of most of our mines, and are there with the one and only idea of grabbing the fees pertaining to such posts. The position is a serious one, especially as regards the loss of efficiency in the control of our gold-mining industry. If I had my way I should declare a Mining St. Bartholomew's Day for the getting rid of this growing mass of incapacity.

I resent the intrusion of this type of man into mining, for the reason that he is inefficient; he is rarely worth his seat on a board, and takes the place of a trained business man whose experience and advice would as a rule be of value. Our mines are too important to be controlled by amateurs, and the loss of efficiency entailed by the presence of all these parasites is probably greater than any one can really estimate.

Suppose that one afternoon I strolled into the House of Lords, and there took an animated part in the discussion on the Deceased Wife's Sister's Bill, or the Disestablishment of Church and State; or picture me appearing at a review on Aldershot Plain, on a white charger, clad in brilliant uniform, my breast ablaze with decorations, shouting hoarse orders to the assembled troops. My conduct, by those chiefly affected, would be mildly described as "most unseemly." But does it never occur to the hard-up peer or general that *his* intrusion into *my* business—incapable and untrained as he is, ousting a better man, not there with any idea of raising the status of mining, but merely to grab the fees pertaining to the post—does it never occur to this person that his conduct may not be similarly described?

Of course, it does not follow that an untitled man is nec

an ideal director, or that a peer, a general, or a retired civil servant, cannot be a capable man of business. A few are, and some of the titled people on boards do quite well. I can sympathize with a man of energy, retired from service at middle age, desiring to retain his grasp on affairs ; but my business is to consider the interests of the mines, and I know, from a wide experience, that the training of such a man has not been to fit him for controlling their destinies. It may be said that four out of every five of the titled type of director could easily be displaced for better men, and that their presence detracts from the value of a big national asset.

The present War Minister of France, who in private life is a successful stockbroker, has forbidden any general officer on the reserve list, or drawing a pension, to become a director of a public company, and gave the following reasons for this :—

“ It is a fact that very few men who have passed the greater part of their lives in the army or navy are capable of understanding the details of a financial affair. This is especially the case with retired military officers of superior rank. These officers frequently receive tempting offers to join the boards of companies promoted by more or less doubtful financiers. The inducement, of course, is the fee which is generally offered, and in the majority of cases the officer is convinced that he is joining a straightforward concern. In order that the public shall not be misled, I have decided in future that no general officer on the Reserve List shall allow his name to appear as a director of a public company.”

This is put diplomatically, but the gist of it lies in the first sentence. If the officer is so ignorant of business and finance, he must be out of place on a board where knowledge of these is essential ; moreover, he is clearly taking money under false pretences. I wish our War Minister would follow this example.

There is a residuum of capable business men who sit on the boards of our gold-mines. Personally, I look forward to the time when the mines will have the services of a class of professional,

non-shareholding directors, specially trained, licensed by Government, and standing much in the same fiduciary position to a company as its auditors do. This body of men would supply one of its number to each board, at a fixed annual fee, according to the mine's importance. All the cables and reports would be opened only by this non-shareholding director, and all information passed on to shareholders, or not, at his discretion. He would not necessarily control the policy of the mine, nor would he carry more than one vote; but on questions of finance, of dividends, of the issuing of reports, and the receiving and giving out of news from the mine, would be the special trustee of the shareholders, and his decision on such matters—the decision, be it remembered, of a specially trained man, and one licensed by Government—could only be set aside in general meeting. If such a man were at the disposal of every company—and it would be the shareholders' fault if he were not—the present domination of the promoter, with his system of secret information, would soon come to an end.

The titled, inefficient director is the product of the company promoter or capitalist. The capitalist is intolerant. He is rich and powerful, possessed, no doubt, of a strong personality, and is accustomed to be masterful. He does not understand independence of spirit in others. The directors are usually his nominees, probably his servants, and the Press is largely at his disposal. Every profession shows blackguards within its ranks, and of late years some mining engineers have become his tools. I am not holding up the capitalist to notice as a villain. He is often a very decent fellow, and so long as his interests do not clash with the good name of gold-mining he is welcome to make all the money he can. But he is entirely a selfish being, and his interests are often not the best interests of the industry as a whole. So far, his influence on mining has not always been a healthy influence.

The mining engineer is awakening from his long sleep to the responsibilities of his position. In the call for an increased national efficiency, our gold-mining industry is much too big an asset to

left to the care of the promoter and the titled director. The engineer is coming to understand that to justify his existence, to deserve the respect of his fellows for himself and his profession, he must come forward, must assert his personality to the utmost, and, indeed, must lead where before he has been content to follow.

I may not read the signs aright. It seems to me, however, that in the mining world the man of knowledge is at last being called to his kingdom. I prophesy that the mining engineer will rise in prestige and in influence, and that the company promoter with his myrmidons will sink to a like extent from now onwards. It will be gradually borne in upon the notice of the nation that the profession of mining engineer calls for high moral and mental qualities ; that it ranks as honourably as that of soldier, sailor, barrister, clergyman, doctor, or scientist ; that it is on the whole a better-paid profession than any of these ; and that as yet there is less competition to be faced. It will follow in due course that this profession will begin to attract its fair share of the best blood and brains in England ; that the Universities will give a degree in mining, as they do now in mathematics, or history, or science ; and that our miners will soon hold the social status and intellectual prestige which the world accords to men of brains and action.

At this time many eyes are directed towards the Institute of Mining and Metallurgy. Every one realizes that the Institute is to become the lever for raising the whole mining status, and that some day all these questions I have referred to—the social position of the engineer, the high mining education, the inefficient director, the past subservience of the engineer to the capitalist in all things, and the general status of the profession--will have to be fearlessly dealt with.

What a grand work the Institute has before it ! The mining profession with us has never yet taken itself seriously. It has barely begun to make its personality felt, and as yet even the Institute has outlined no definite standard, in black and white, of professional conduct for its members. If a doctor by his carelessness caused a patient's death ; if a pilot fuddled with drink ran his vessel on the

rocks ; would that man be called to no account by his associates ? Why, then, should a miner be exempt from authority ? Why should a manager who deliberately wrecks his mine for stock-jobbing purposes, or who makes culpable misstatements about his ore reserves, or an engineer who writes a trashy, emasculated report on a property, not be arraigned for the harm he does his profession, and censured according to his degree of wrong-doing ? The wider view which the engineer is beginning to take of his duties must embrace a strict code of professional action, and hitherto accepted standards must pass under revision.

But let it be noted that the Institute is becoming alive to the great work it can do, and, no longer considering itself as only an invertebrate centre for the circulation of technical literature, now knows its real function is to foster the production of cultured and honourable men. The pamphlet issued by it, dealing with ore-reserves, was a memorable document, which will have far-reaching consequences. A second step is the appointment of committees to report on standardization, and here, again, is a move forward of the first importance.

I quote here a part of the last presidential address to the Institute :—

“ In order to arrive at an estimate of the value of a mine it is agreed that the two important factors are, firstly, the ore, ‘ in sight,’ which can be turned into dividends, and secondly, the prospects for the future beyond what can be considered ‘ in sight.’

“ It has now come to be recognised by mining companies that they are expected to give shareholders, periodically, a correct statement of the ore ‘ in sight,’ but as regards the second factor above referred to, the appearance of the bottom of the mine and the future prospects, there is often room for very much more candour. Too often the first intimation a shareholder gets that something is wrong with his mine is given by the falling market value of shares.



TAKING MACHINERY TO THE TASMANIA MINE

"It may be stated, broadly, that a manager of a mine, in his periodical letters, gives free expression of his hopes and fears, and that any important change for better or for worse is, as a rule, foreshadowed in them a long time before it happens. Why should not the shareholders have this information, which is obtained at their expense and would be of much use to them in aiding them to form a just estimate of the value of their property?

"It might be argued that there are subjects which could not be so well dealt with if the manager's letters were accessible to shareholders, such as private reports about the staff, or the desirability of acquiring any particular neighbouring property, and so on. This objection, however, could be got over by dealing with such subjects in special private letters.

"Another objection might be made that it is not wise to let the shareholder know too much, as he might be led to form hasty conclusions. I think this danger is much more imaginary than real, and, moreover, if the shareholder did do this it would be his own affair. On the other hand, the dangers and losses to the public caused by the common system of giving as little information as possible, are very real.

"I believe it would be found that the shareholder is nervous and timorous largely because he is kept so much in the dark, and that if he felt that all known information on the subject of his property was at his disposal, and that he could read, if he wished to, the manager's letters at the company's office, he would be much more stolid than many directors imagine. At present it may be said that even under the most favourable circumstances only once in a year, and that immediately after the publication of the manager's Annual Report, is the information of the ordinary shareholder up-to-date.

"The figures and measurements, usually fortnightly, are all very well as far as they go; but even to get their full significance they must be grouped, compared, and commented on by someone who has all the facts at his fingers' end, as the manager has. My point is, that if you or I, whose business it is to understand mines and

mining reports, feel so often in the dark, what must the state of the ordinary shareholder be?

“When dealing with this subject, I should like to make a vigorous protest against the system, now happily becoming more and more rare, of closing mines to the public. No doubt in each case where it is being done, or has been done, plausible reason can be given. I think, however, there is a great deal of sound common sense in the old, but somewhat homely, saying that the ‘proof of the pudding lies in the eating,’ and in this case the result has, in the majority of cases, been unfortunate for the general public. If a mine is owned by an individual, or a few large shareholders, there is, no doubt, a perfect right to close it against visitors. In the case, however, of a mine which is owned by a public company, the shares of which are actively dealt with, and which the public are invited to buy and sell freely, the same argument, I maintain, does not apply.

“It is sometimes urged that the taking round of visitors may become a nuisance and a source of expense to the company; but there is nothing much in this, and moreover, no visitor who really wishes to go underground would object to paying a small fee, as is sometimes charged, of, say, 5s. or 10s. to a miners’ accident fund, or something of that kind, for the privilege.

“Personally, I always regard a mine which makes great difficulty about letting visitors go underground, and will not give information freely about the workings, and so on, with the very greatest suspicion, and have found that events usually justify that view. In the last four or five years three mines have come under my notice which were subsequently the cause of a so-called mining scandal, and it is worth noting that in each case great mystery was made about giving any information concerning the workings to visitors, and difficulty was made in regard to going underground.

“It would appear that if anything is kept concealed about a mine, some astute individual is pretty sure sooner or later to turn it to his own advantage at the expense of the public.

“A system which seems to have a great deal to recommend

is for the manager to be empowered to regard all information regarding his mine as open to the public, after it has been reported to the head office, and sufficient time has elapsed to allow for its publication. This system is being acted on in some of the best-managed mines, and I have not heard the managers complain about it, while the protection thereby afforded to the public is very considerable."

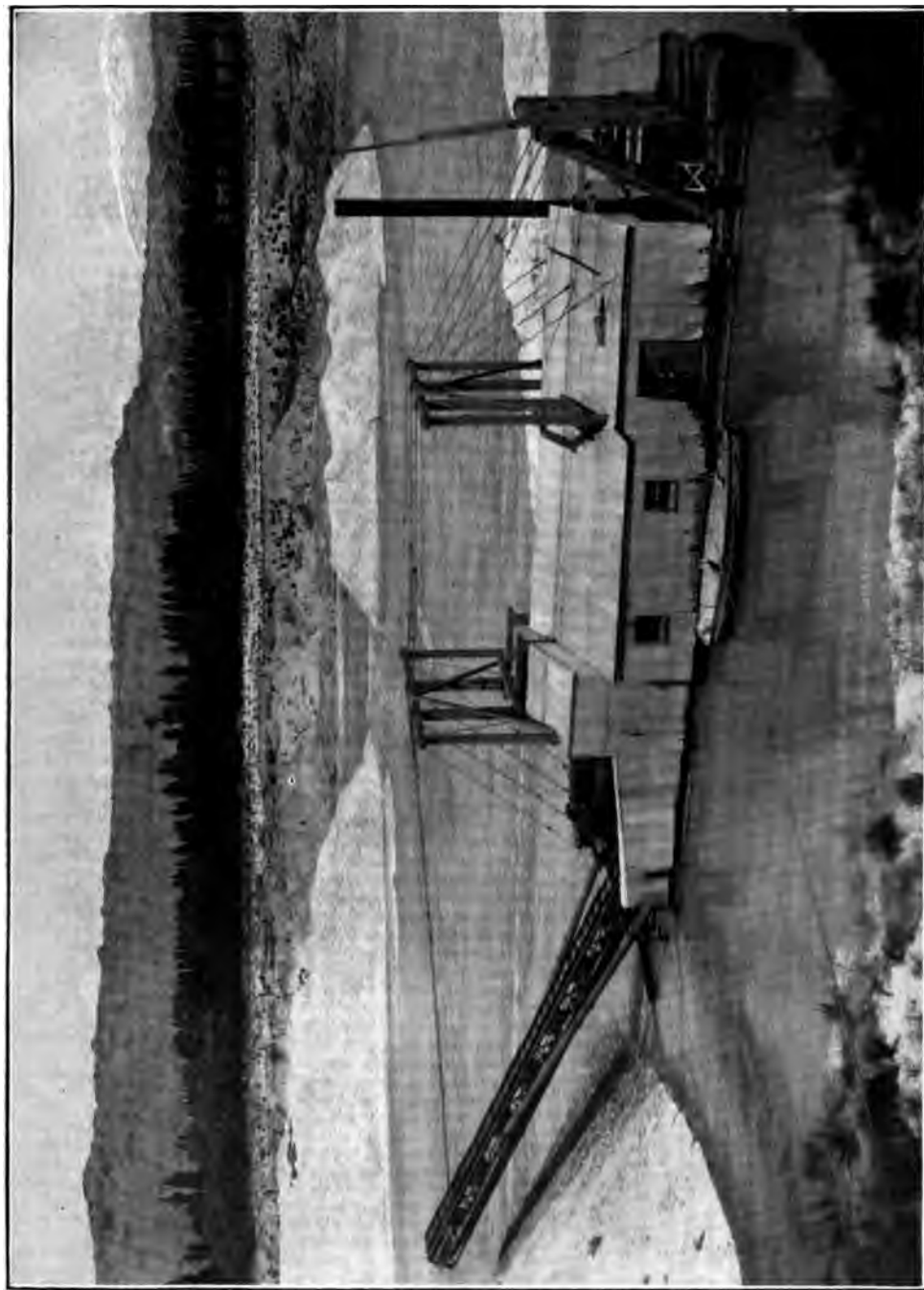
The day is coming when the Institute will wield exceptional influence and authority. In that day it will be looked to as arbiter by the whole world of gold-mining, and before its united front the present evils and weaknesses of the mining industry and the mining profession will fall away even as soft ground falls before the rock-drill. Let us all try to bring that day nearer.

CHAPTER III

THE ECONOMIC FACTOR

IN gold-mining the "Money Sense" is the supreme faculty. Its most decisive function is ore-valuation ; but the man who possesses this faculty will bring it to bear on every problem he has to face. The aim of mining is to make money, and one would expect its economic aspect to be understood by those who engage therein ; but it is demonstrable that the majority do not probe the economic aspect deeply, and that the true " Money Sense " is as rare as it is valuable.

Among the hundreds of mining reports it has been my lot at one time or another to read, those which presented the issue in clearly cut language were pitiably few. An engineer in examining a mine may be called upon to pass in review a thousand different questions ; but these, to the clear thinker, inevitably resolve themselves into but two or three, and any ordinary report can be summarized in one short paragraph. If a man has the " money sense," his report will be short and pithy, and he will stick to the point—that is to say, to the money aspect of the problem. If he has not this gift—if he cannot train his reasoning on to the main issue—he will produce a long, tedious report, full of useless erudition, carrying conviction inversely as to the square of its dimensions. Simplicity is often the keynote of greatness : I will add my belief that simplicity in a mining report—throwing into relief only the one broad money issue, and treating all the rest as detail—is the likely outcome and direct mind.



A DREDGE ON MOLYNEUX RIVER, NEW ZEALAND

The direct type of mind, which brushes aside ambiguity and will not tolerate the casuistic methods which tend to bring gold-mining into disrepute, is now coming to be more in evidence. As a beginning, its attention fixed itself on the lax way of describing ore reserves. The Institute of Mining and Metallurgy—the governing body, so to speak, of the gold-mining world—took this question up, with the satisfactory result referred to elsewhere.

The next subject for reform in this direction is that dealing with the standardization of mining results and statements, and on this question the Institute has already appointed a committee to report.

I hope this committee will report in favour of the following standards :—

- (1) The mining ton to be of 2000 lb.
- (2) The abolition of troy measurement, except for purely technical purposes. All returns, assays, etc., should be given in sterling or in United States dollars. There is no sound reason for telling a shareholder in a mine that its ore is worth 15 dwt. 8 gr. to the ton and that the expenses will be 10 dwt. per ton. He will first want to know what a dwt. is, for it may vary anywhere from say 2s. to 4s. 3d., and after you have explained to him what your particular dwt. is, he will have to sit down and calculate the sum out into sterling. On the other hand, if you report to the shareholder that the ore will yield 65s. a ton, and that the net profit is figured to be 24s. a ton, you both save yourself trouble and satisfy him.
- (3) Should bullion be referred to, it must only be in terms of fine gold, i.e. 1000 fine, worth 84s. 11½d. or \$20·67 per oz.
- (4) When assays giving the value of ore *in situ* are published, the width of ore sampled must accompany the assay value.

I hope the time is approaching when the system of standardization will be extended to mining costs and to mining accounts. At present the methods for each of these are legion, and seem designed to conceal rather than reveal the financial position; but there must be some one method, in accounts especially, which is the best of all,

and with the assistance of skilled accountants and an actuary or two the Institute should be able to draft here a great reform.

The "Economic Factor," or the relation of a mine to its surroundings—and a phase of the "Money Sense"—falls here to be considered. The Economic Factor embraces such questions as Government, climate, labour, means of transport, water and fuel; to translate these into terms of money will explain why one mine can work at 5s. a ton and another at not less than 65s.

I will illustrate these several points.

Government, as an adverse factor, has tended to close many parts of South America to foreign mining capital. If the government of all the South American States was as stable as, for example, Mexico, or even if it were equal to the best South American standard, which I suppose to be Chili, there would be, no doubt, a big mining industry spring up; and such states as Argentina, Bolivia, Peru, Venezuela, and Colombia, would receive great impetus from this source.

Under stable government the whole of these States should be able to bring their money values to a fixed basis. In Brazil to-day the fluctuation in exchange is the worst problem the gold-mines have to face.

Under this question of government one must take note of the tendency to socialism in Australasia, and the growing power of the labour vote. As yet this has been kept in restraint; but there is the possibility that some day one or other of the labour ministries will carry through legislation which will tend to alienate capital.

Climate is a factor of wider application. Heat, cold, altitude, fever—things of no moment to the company promoter, or to the thoughtless speculator—are very real when the "Money Sense" is turned on to them. Observe the position of the West African mines when analysed in this way. The extreme heat there is not of itself a impediment, but the mines are in a deadly fever country,

the death-rate is very high. As a result, most of the best men will not go to West Africa.

But even suppose good men would go there. If such men wish to retain a semblance of health, they and their staffs must return to England frequently, and for considerable periods, drawing pay meanwhile. In the intervals the control is handed over, in relays, to a second manager and second staff, which, besides being most expensive, is deplorable as regards continuity of policy and method. Owing to the climate, no persons of authority in the mining world visit that field, and no clear statement about the mines there, as a whole, has been published. West African managers have had no one to check their statements. This cannot be helped. But the result is that a body of, on the whole, somewhat inexperienced men, are saddled with a greater responsibility than more experienced men are on more safely reached mining fields. If these men make mistakes in their figures, or statements; if they fail to assert their personalities against injudicious boards of directors, we must judge them with some lenience. But the economic factor as regards West Africa is certainly all wrong. Whatever others may care to do, the man with the "money sense," or with the direct type of mind, will have no dealings with that country.

Cold is another sub-climatic factor.

In Siberia, for example, a quartz-mine might be worked to advantage in the summer, and might be floated in London on the basis of a summer's work. But winter would change the aspect of the problem. I think it is indeed doubtful whether a quartz-mine could be worked profitably in Siberia for more than five months in the year. The profits over such a short season would be relatively small, and the payment of the staff during the inactive months would seriously deplete these.

But supposing such a mine were worked through the winter, all the surface plant, including the cyanide vats, and sumps for the mill-water and for the cyanide solutions, would have to be under a thick cover, and the building of such would be a heavy item of expense.

A scarcity of running water might also be expected, and the use of the water over and over again would create such conditions as would lead to a poor extraction. Assuming, as is reasonable, that such a mine was of medium or low grade, and required a large mill and a big plant in order to earn substantial profits, the heating for all this would be a heavy item. There are, indeed, problems connected with quartz-mining on a big scale in winter in Siberia, which cannot be lightly answered, and I am not here prepared to say to just what extent it is practicable.

The "Money Sense," if brought to bear on some such individual problem, would veto any flotation until, at least, the figures of a winter's work with a small equipment of plant and machinery were available.

The factor of altitude is of less importance, but this sometimes crops up in connexion with South America. At the Cerro de Pasco copper-mines, in Peru, at 15,000 feet high, I found that experience showed that half the men sent up there from the States could not stand the altitude, while the efficiency of almost all the rest was impaired. An ore-body at anything from 14,000 to 16,000 feet must be unusually rich to be worth handling; while at more than 16,000 feet the economic factor would be greatly strained.

The mental aspect of climate is also worth noting. A friend of mine was for some years in charge of a prospecting expedition in the Sudan, with his camp located most of the time in one place. He described the experience as "a dog's life." Several of his men—hardened Cornish miners—had left, on the verge of nervous break-down. As for myself, in the few days I spent there, I got an attack of depression it took some months to shake off; and I am sure that a year of such life would put me beyond the reach of my enemies. Of course, where mining is in full swing and every one is busy, there is less room for nervous depression, even in the Sudan; but the desert is not a healthy mental background for the miner.

Labour is a main point in the economic factor. It was the proximity, in the early days of the Rand, of a large amount of cheap and effective labour, which made that field so successful. If there had been no natives to work for a shilling a day, if the same work had fallen to be done by the whites, at 20s. to 25s. a day, only a dozen or so of the mines could have been worked at a profit. At a later date the demand for cheap labour outran the supply. Hundreds of mines had been floated at big figures, and no cheap labour could be found for these locally. Fortunately Chinese labour was introduced. Had it not been there would, in my opinion, have been a serious financial catastrophe in South Africa and England.

Experience shows that the skilled white miner, handling an air-drill, is more efficient than the unskilled white, even if the latter works at half the price. Comparing the skilled white to the coloured worker is more difficult, for the native has what the unskilled white has not—muscle; and muscle saves compressed air. In the Transvaal, where the skilled white miner receives 20s. a day, and where the ore is often too narrow for effective air drilling, he can never compete quite effectively with the muscular Kaffir or Chinaman. On other fields the skilled miner receives an average of just about 11s. a day, and can compete more nearly with the coloured man. When this rate of pay obtains in the Transvaal we shall find the labour phase of the economic factor there ready for readjustment.

A mine's location with regard to the delivery of machinery and supplies is the next factor. In West Africa, until the railway was built, machinery could only be taken through the forest by carriers, and no mortar-box could be sent in whole. A mortar-box built in sections is next to worthless for serious crushing, and a big output of ore from any of the mines was therefore out of the question. This fact did not prevent many people buying West African shares at big premiums, before the railway was ever thought of. They and their advisers lacked the "Money Sense." In the Sudan there

is camel transport; which is slow, and only effective for light weights. If heavy machinery is required it will be nearly impossible to drag this with camels over the sand. A light railway must therefore be built; but distances are very great, and for a mine—still in the prospecting stage, when its future is not assured—to have to put in a line of perhaps 60 or 100 miles is a big risk. The factor of location here makes itself felt. In Peru, a gold-mine located on the eastern slopes of the Andes is reached, as to the last 50 miles from the coast, by a bridle-track, descending from 16,000 to 2000 feet. There are only ten stamps at this mine, but for some time very rich ore was found and large profits made. Now the rich ore has come to an end, as was to be expected. There is probably a lot of low-grade ore remaining, but it is a nice question as to whether a big low-grade mine can be effectively run in a location such as this. It is probable that a wagon road would first have to be cut out of the solid rock at enormous cost, and until a great deal of low-grade ore had first been exposed such an expenditure would not be economically justifiable. In a case like this the "factor of location" becomes all-important.

The next factor is water. Owing to the large amount required for milling, concentrating, and cyaniding, a good supply of water is essential to nearly every gold-mine. If the supply should be very great and the contour of the ground permit, water can further be used as motor power; but there are relatively few mines in a position to use such. Water in excess is always a serious factor. The fate of the "deep lead" mines in Victoria hangs on the water question. The existence of payable gold in these has been demonstrated almost beyond doubt—provided the water is got rid of. Preparations are being made to master the big flow of water at all costs, and to pump from the several mines, if need be, 20,000,000 gallons a day. The chances are that these efforts will be successful; but to attempt to master this water by any less thorough plan would end in failure. The Tasmania mine uses 3,000,000 gallons of water daily for years without reduc-



STEAM SHOVEL AT MOUNT MORGAN

and with the then capacity of the pumps the mine could be sunk no deeper. Pumps of six to eight million gallons capacity are now being put in. But however well a mine like this may do, the menace of this tremendous flow of water will always have to be faced. A mine where water is likely to be an all-important factor is Waihi Grand Junction. The best ore in this mine seems to be that which dips from the Waihi chute at a depth of, roughly speaking, 1000 feet. But to reach this the Grand Junction workings must be deeper than those in Waihi, and the big flow of water now being handled by Waihi, plus an extra cost for the greater height to be raised, will fall on the Grand Junction. The water factor here must not be underrated.

The aspect of the water factor can become abstruse. The Kalgoorlie mines have, for example greatly benefited by the Government water scheme, which brings in fresh water from over 300 miles away. Indirectly the whole mining industry and the trade of West Australia has benefited also. The other aspect of the scheme is that it cost some £3,500,000, and that its earning capacity, while perhaps sufficient to pay interest on this loan, is not sufficient to pay any sinking fund. In course of time the mines will be worked out; the £3,500,000 will earn no interest, and the repayment of this large sum will have to be made from the general finances of the colony. But West Australia is dependent to an exceptional degree on its mines. If those are worked out the general finances will be in a bad state; the repayment of the money raised for the water scheme will strain the prosperity of the country; and the present benefits of the scheme may be less than the eventual reaction when the money shall have to be paid back.

There is no reason why big water schemes for mining districts should not be considered by governments. Two provisions are needed in any such scheme. First, that the quantity and value of ore exposed in the districts to be supplied with water should be reported on, which was not done in the case of the Coolgardie

scheme ; second, that the repayment of the money should be made over a short period, and that the sinking fund should take the form of a royalty on each ton of ore mined. Two such schemes are, I believe, worth inquiring into. The Government of Chili should consider the possibility of conveying water to the great copper deposits of the Atacama desert, and the Government of Canada, with a view to regenerate the failing Klondyke field, should inquire into the question of carrying water in there. The greater part of the gold in the Klondyke gravels, owing to the high cost of labour, cannot be handled except by hydraulicing. On this basis, however, the gravels are rich, and their extent is probably great enough to justify a big outlay on a water scheme. The main question is as to whether water can be brought in under a big enough head to be effective. From my observations I should say that possibly it could be, and that the gravels are rich enough and of sufficient extent to justify the scheme. The inference is that the Dominion Government can afford to at least inquire into this matter.

Water, as an economic factor, is the essence of the dredging industry. Water floats the dredge, sluices the gravel, disposes of the tailings ; to work such ground at a profit, without a dredge, would be just as impossible as to work a dredge without a big flow of water.

Fuel, as a factor, is as a rule not so acute a question as water. If the mine is so located that supplies can be carried in without great cost, fuel of sorts is always to be got. The Rand mines, fortunate in their local supply of cheap and muscular labour, are equally fortunate in their supply of fuel. Within a few miles of the mines is a large quantity of fair steam coal, and within a hundred miles is an inexhaustible amount. Each mine is now connected by a siding to the railway, and the coal, after being mined, is dumped into the bunkers of the gold-mines without further handling. On one of the East Rand collieries a large amount of electricity is also generated and transmitted all along the reef. In Rhodesia is of a better quality, but is much further removed from the

Up to the present these have burnt wood, but that is now scarce in the vicinity of mines. In West Australia the mines burn wood, which, as regards Kalgoorlie at least, will last for a long time; in outside districts a change to coal may have to be made. There is some coal of poor quality near the coast, which may or may not be able to compete with coal from New South Wales.

Fuel, or the lack of it, will be a serious problem in Egypt and the Sudan, but the new railway from Suakin to Berber will allow of Indian coal (paying no Suez Canal dues) to be brought in at a reduction on the present rates for coal from England. Oil, as fuel, is being used on some of the Californian mines, and is economically successful. It is probable that mines within easy access of oil-fields, such as Sumatra and Borneo, may find this their best fuel; but in the East this factor is rarely serious.

“Mine-valuation” is the application of the “Money Sense” to the ore-deposit itself. When the mine has been duly sampled, assayed and measured, and its probable costs determined—in the light of evidence furnished by the “Economic Factor”—the main points can be reached. These points are:—

- (a) The amount of ore exposed, and its probable relation to unexposed ore.
- (b) The net profit in the exposed ore.
- (c) The correct valuation of the exposed ore, plus an allowance for unexposed ore.

This subject is dealt with in the next chapter.

It may be said, as bearing on the “Economic Factor,” that as a rule a quartz-mine can be more accurately valued than an alluvial or placer mine of any sort, and that a large ore-body even of low grade is a likelier venture than a rich small reef.

If I had to choose between two undeveloped mines—one a reef 2 feet wide and 1000 feet long, worth £10 a ton, and the other 10 feet wide and 1000 feet long, worth £2 a ton, I should choose the latter. These would carry the same amount of gold to each

foot of depth, and the cheaper equipment of the small mine would be in its favour; on the other hand, the richer ore-body would probably indicate a secondary enrichment lasting to a shallow depth only. The larger body would probably live to a greater depth without impoverishment, while the bigger scale on which it would be handled would mean smaller working costs.

The "Economic Factor," or the relation of a mine to its surroundings, is seen to greatest advantage in the case of the Alaska Treadwell. The government is stable. The climate is healthy. Skilled white labour is available. The mine is located on an island within a few hundred feet of deep water, ensuring the cheapest transport. There is a sufficient fresh-water supply for all requirements, and in the summer months enough even for generating power. Fine British Columbia coal is landed at the company's wharf, and the returning steamer carries concentrates to the allied smelter at Tacoma.

Thus the surroundings. The lode itself is of immense width, standing almost vertical, and its walls are strong. Owing to these facts, pillars of ore left standing are all that are required; there is no costly timbering or filling; and the effective method of breaking a stope full of ore, which is then made to empty itself, is feasible. The ore is easily treated, and yields a high extraction. Simple milling and concentrating is all that is required; the tailings, too poor for treatment, run into the sea, and are dissipated by the tides. Finally, there are 540 stamps.

Alaska Treadwell ore is worth on the average less than 9s. a ton, but this deposit, which in most other parts of the world could not be handled at all, is here worked for 5s. a ton, and has paid over £1,000,000 in dividends. It is the "Economic Factor" in its highest application.

CHAPTER IV

“ MINE-VALUATION ”

It is good common sense that a mine's value should depend on its ore, and that all other factors bearing on it should be judged of only in relation to the ore. This is the correct way to value a mine, but the number of people who are able to think along this line of deadly simplicity is limited. There is only one question to put and to answer about the average mine. What is the net profit in sight in the ore? And the man who has got this question crystallized in his brain is the man who will become the successful mine-valuer.

The so-called mining engineer ought to be, but often is not, in the true sense, a mine-valuer. If sent to report on a property, such a man will produce a document of from thirty to sixty pages, beautifully typed, teeming with such facts as what country the mine is located in, who discovered it, its latitude and longitude, the average yearly temperature, the physique of the local miner, and the improbability of lowering his rate of pay. In more serious vein he will range through the known phenomena of geology, metallurgy, and engineering, but on the one vital point of all—the quantity and value of ore exposed in the mine—will show himself vague and unconvincing. It is clear that such a man is out of place in mine-valuation.

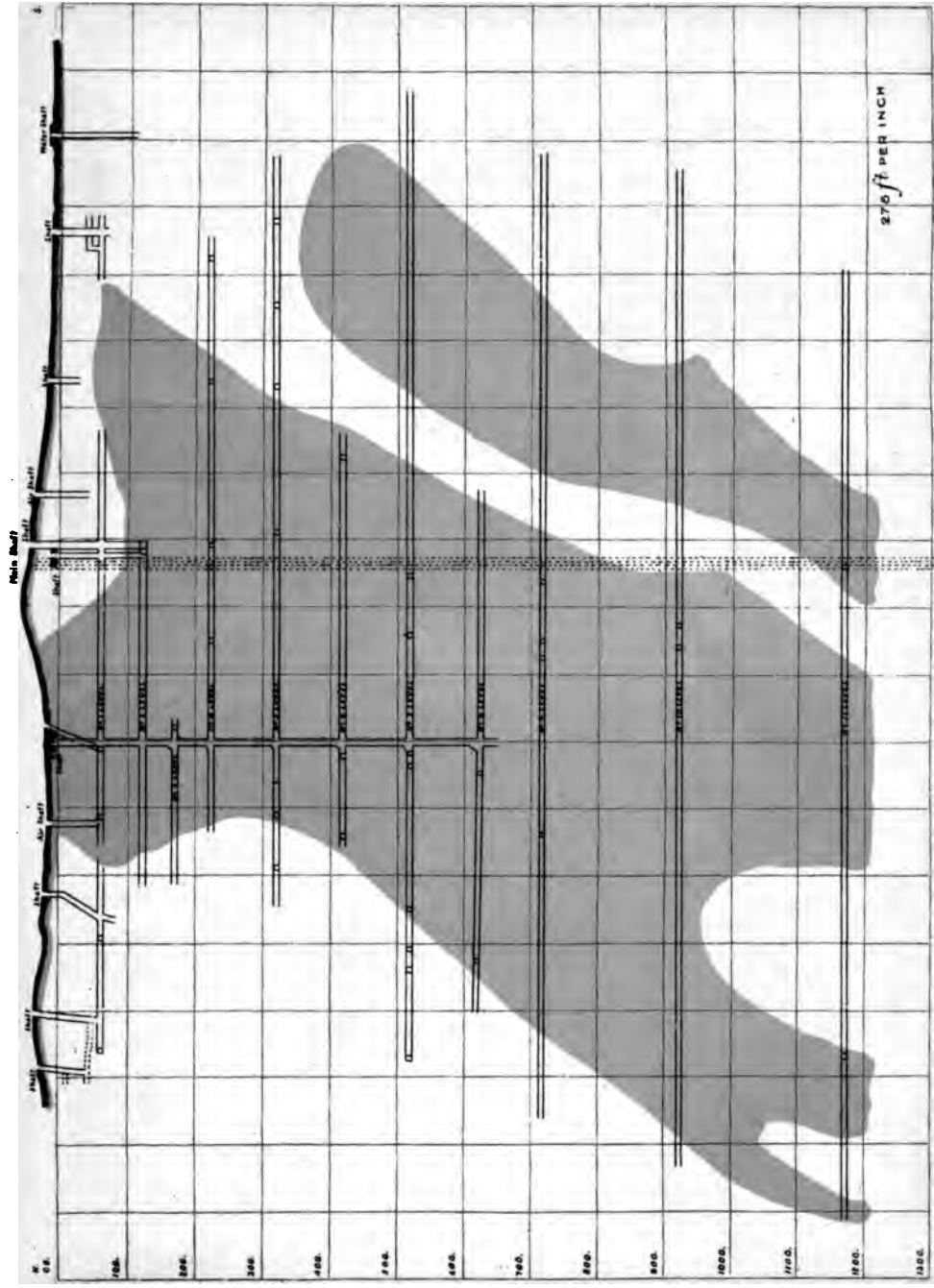
As for the layman, he has a hundred reasons for buying shares in a mine. He may buy from sentiment, or because his friends are interested, because his favourite paper speaks well of the shares, because current dividends are large, because the mine is controlled

by a strong financial house, because there are "ancient workings," because it is within a few yards or a few miles of a payable mine, because he has made money in the shares before, or because the Conservatives are in power. Almost the only thing he will *not* take into account is the mine itself, and the evidence for or against it, as shown by the ore.

But, believe me, it is the ore that counts. Geology, metallurgy, engineering, have their high place, but to be a good judge of a mine, to be sound in mine-valuation, whether you are layman or professional, is the direct road to fame and fortune in this particular sphere of industry. . . .

The sampling and measuring of ore is a subject of technical rather than general interest, and I propose to deal with it only in outline.

Methods of sampling vary, but in essential points there is something like an accepted standard. All mine-valuers agree as to the need of extreme care in taking the samples, and in assaying them, and will make sure that their assistants in this work are thorough. It is agreed that samples should be taken at not greater distances apart than five feet, and that a sample is more reliable if quartered down from thirty or fifty pounds of ore than from, say, three or four pounds. If the width of ore to be sampled were only a few inches, it would, of course, be difficult to get more than a few pounds of ore for the sample, but if it were, say, five feet wide, a sample weighing forty pounds could be taken. When a wide ore-body carries its value in streaks, it is usual to sample a face in sections. In many ores the main value is in a small streak of the reef, or is in the softer portions; the experienced sampler will exercise care that no sample carries an undue proportion of the parts. The assays should be made in duplicate, or preferably in triplicate, and the mean of the resulting beads taken. If the ore is low-grade, carrying its value with fair regularity, the problem is simplified, and the chance of inaccuracy lessened. Where the values vary greatly at distances there is less security, and ore of this nature :



ORE CHUTES IN GREAT FINGALL MINE.

sampled preferably every three feet. If unusually high assays occur here and there, these are always reduced. One man will reduce them to the mean of the two adjacent samples, another will cut them down to a maximum figure, a third will re-sample that spot, in the hope of getting a normal assay. Experience bears out the view that it is right to reduce fantastic assays.

It may be stated here that now and then one finds an ore on which even the closest sampling is not a guarantee of results. In such an ore the values probably occur in splashes of free gold, the bulk of the ore being quite unpayable. A series of fifty samples along such a reef might show forty-seven to be unpayable, one to be of fair value, and two, with a lot of free gold in them, to run up to hundreds of pounds to the ton. The mine-valuer would not attempt to place a definite value on such a mine by sampling only, and this is not the class of venture which the outsider should buy into. Fortunately this sort of mine is rarely met with.

After the ore has been sampled and assayed it has to be measured up. The experienced mine-valuer will not vouch for the existence of any block of ore that has not been sampled on three sides. If the centre of the block so sampled should be more than 50 feet from any of the places sampled, or, at any rate, 100 feet, and should the mine show "spotty" values, he would probably refuse to assign to this central area the average value of the rest of the block. Ore blocked out on two sides only is not strictly "in sight," and cannot be assumed with the certainty of that blocked out on four or three sides.

The following memorandum on "ore-reserves" has been issued to the members by the Council of the Institute of Mining and Metallurgy :—

"After due consideration and discussion, the Council came to the following decision :—

"1. That Members of the Institution should not make use of the term 'ore in sight' in their reports, without indicating, in the most

explicit manner, the data upon which the estimate is based ; and that it is most desirable that estimates should be illustrated by drawings.

“ 2. That as the term ‘ ore in sight ’ is frequently used to indicate two separate factors in an estimate, namely :

“ (a) Ore blocked out—that is, ore exposed on at least three sides within reasonable distance of each other—and

“ (b) Ore which may be reasonably assumed to exist, though not actually ‘ blocked out ’ ;

these two factors should in all cases be kept distinct, as (a) is governed by fixed rules, whilst (b) is dependent upon individual judgment and local experience.

“ 3. That in making use of the term ‘ ore in sight ’ an engineer should demonstrate that the ore so denominated is capable of being profitably extracted under the working conditions obtaining in the district.

“ 4. That the Members of the Institute be urged to protect the best interests of the Profession by using their influence in every way possible to prevent and discourage the use of the term ‘ ore in sight ’ except as defined above ; and the Council also strongly advise that no ambiguity or mystery in this connexion should be tolerated, as they (the Council) consider that such ambiguity is an indication of dishonesty and incompetency.”

The competent valuer does not claim to know much about the unexposed ore in a mine. He will speak with confidence about what is “ blocked out ” ; he will also make due allowance for ore that may be reasonably assumed to exist ; but as to the possibilities of the mine beyond those limits he will be very guarded in his statements. A wide experience of ore-bodies brings home to one their uncertainty. Where they are exposed and can be sampled and measured, well and good ; beyond that there is danger. The ore itself may narrow down, or die out altogether ; or continue, but with a less or an unpayable value.

Mines almost invariably become poor with depth, and gold-mines are no exception to this rule. I do not mean that each level shows a steady falling-off in value from the level above it ; but the first 500 feet of a mine will probably be richer than the second, the second richer than the third, the third richer than the fourth. Few payable ore-bodies go down so deep as this. I have seen many mines get into unpayable ore at about 200 feet deep. Another depth that mines often go wrong is about 800 feet ; but, naturally, there is no law to guide one's judgment.

We can only surmise as to how reefs were themselves formed. It is thought that the metals in them were deposited from solutions, which percolated these cracks and fissures at perhaps a much later period. The solutions which have thus enriched the lodes no doubt in most cases came from below ; but local or secondary enrichment at shallow depths, due to descending solutions, is not unusual.

A person without knowledge of mines may say, " But if the solutions came from below, surely they would have deposited their metal contents all the way up, and the mine would, therefore, instead of getting poorer, become even richer in depth." The answer to this is that the metal-carrying solutions were under too great pressure and heat to deposit their contents. It was only when they had been forced up to near the surface, where the rock was cooler, that the pressure was relaxed, and the temperature sufficiently lowered to allow of a deposition of their metals. That, then, together with the frequent phenomena of secondary enrichment, is the reason why a mine is so often richest near the surface and gets poorer the deeper it is explored. " Mysore is a fluke," a mining engineer said to me. That was his terse way of summing up the wonderful ore-chute which, although not so rich as it was, is still strong and payable at 3000 feet deep.

There have been other persistent ore-chutes in gold-mines, but there is nothing in quartz-mines—unless it be Morro Velho in Brazil—that has held in depth like Mysore. Mines at Charters Towers have paid

at below 2000 feet, but not much below that. The saddle-reefs at Bendigo have had good patches below 2000 feet, even to 4000 feet; but, on an average, work below 2000 feet has on that field been carried on at a loss. At Grass Valley, California, the North Star is a profitable mine at, I believe, nearly 3000 feet, and in Colorado the Smuggler Union only became unpayable at about 2500 feet.

But these and a few other exceptions do not prove much. For every gold-mine payable below 2000 feet, I could name a hundred that were not payable at anything like that depth. Many well-known and valuable mines never reached, or never will reach, to 1000 feet, and the ore-chutes that have given out at a less depth than 500 feet can hardly be numbered.

There are, no doubt, men engaged in mining who, reasoning from scanty data, believe mines are as likely to improve in depth as to get poorer. A fallacy of this sort, if widely held, would lead to disastrous results. In a manager's report lying before me, referring to the rather doubtful aspect of his mine at a depth of 300 feet, he makes this statement:—

“It must be borne in mind that our workings are still shallow, and the results obtained so far will compare very favourably with the developments at a similar depth of the most important mines at Kolar, and also in other parts of the world.”

His inference that mines improve with depth is not borne out by facts.

A history of gold ore-chutes has yet to be written, showing their dimensions and values at given depths, and the points at which they either died out or ceased to carry payable values. Such statistics would be of no little assistance to the mine-valuer. When a mine is being bought or sold, the valuers who represent buyer and seller can as a rule agree as to the quantity and value of the exposed ore, but on the question of the unexposed or assumed ore there will be a difference of opinion. As a rule, a mine cannot be bought for its net value of its blocked-out ore, and all mine-valuers v



A JOHANNESBURG MINE AT NIGHT

it is permissible to pay something for what may be called the "good-will" of the ore-chute. As to how much to pay will depend on questions such as the geologic soundness of the formation, the width of the ore, the length of the chute, the depth of the lowest exposed ore, and the evidence in adjacent mines.

Let us take a typical case. A mine is being valued for purchase. It has a reef 8 feet wide and an ore-chute 600 feet long; it has been developed to the 400-foot level, at which point there is no falling-off in width or value; below this no work has been done. We will suppose the engineers representing buyer and seller agree as to the quantity and value of ore from the surface down to the 400-foot level. The question as to the purchase hinges upon the amount of risk the buyer's engineer will take about the unexposed ore below that point. There is no rule about this. The engineer may or may not have the data of many ore-chutes in his possession, but if he is an experienced man he will realize the uncertainty and the danger of assuming too much.

If he is ultra-cautious he will allow for a further depth of about 50 feet only. On this basis the purchase would no doubt fall through. It does not follow that the engineer's action is to be necessarily looked on as unsound. Taking note of the further capital expenditure needed, and the loss of interest due to the gradual return of the cash locked up in such a purchase, he is in reality allowing for the existence of considerably more than 50 feet of ore. Another man, of perhaps less strength of character, would place the position before his principals, and on learning that they, with their eyes open, were not averse to taking a considerable amount of risk, might decide to assume 150 or perhaps 250 feet of ore below what he could see. If so much as this were assumed, the mine would no doubt show a theoretical margin of profit above the purchase price, and the deal would go through. Personally, in a case like this I should bring to bear a theory of my own, which is that a pay-chute is liable to extend further in length than in depth. As the chute in question is supposed to be 600 feet long, and already proved to be

400 feet deep, I would not assume its existence for a further depth of more than 200 feet. I would also bear in mind that a chute is liable to taper off in value before going wrong altogether, and would, therefore, write off a certain sum for such possible impoverishment. If I had to come to a definite decision about this ore-chute I should allow for—at the most—100 feet of assumed ore below the bottom level. If on this basis the purchase could not go through, I would suggest to the buyer and seller that the ore already blocked out should be paid for according to valuation, and that all further ore should be subject to a royalty, as from the new owner to the old. There was a deal something of this kind when the Camp Bird Mine was floated, and it set a precedent which I heartily commend.

If gold-mines were bought and sold on the basis of their ore-reserve, plus a reasonable price for the unexposed ore, gold-mining would begin to assume the aspect of industrial ventures. Especially would this be the case if the price paid referred only to the exposed ore, leaving the unexposed ore to be paid for on a royalty basis. Though not followed in England, this common-sense way of valuing a mine on its blocked-out reserves has been understood in the States for a long time.

Carrying this train of reasoning to its logical issue, it can be seen that a mine floated with no ore-reserve, but merely with an undeveloped reef, should be capitalized on a most modest basis. In such a venture all the risk is taken by those who provide the capital for developing the mine. These people have no initial security for their money in the shape of ore-reserves, and if the mine turns out a success it is only right that they should have the bulk of the profit. In a venture of this sort the vendor is not entitled to any cash, and only to a relatively small percentage of free shares. If he believes in the mine, he should be prepared to take no shares at all until it has been proved, and then to take a royalty of so much afterwards.

The British method of floating gold-mines has been based on no system. In the days of the West Australian boom hundreds of ventures were floated with from £100,000 to £750,000 capital. None of these had a ton of ore in sight, but they mostly had a reef, or reefs, outcropping, and perhaps carrying gold. These indications were generally good enough to warrant the flotation of a £50,000 prospecting company, of which £40,000 should have been cash, for working capital, and £10,000 should have been free shares to the vendor and the company promoter. On that basis West Australia would have turned out successfully for the British. Or take the cases of Rhodesia, West Africa, Egypt, and the Sudan. Here again, although hundreds of mines have been floated for big capitals, there has been an absence of ore-reserves; or, in other words, there has been no security. On all these fields there are "ancient workings," and the speculating public has been so unwise as to accept these in lieu of blocked-out ore, and to pay big figures for them. The result will naturally be disastrous; but it will, no doubt, have the effect of turning people's minds towards a safer and more scientific system of valuing mines.

I have been told that if my ideas prevailed, only mines with big ore-reserves would ever be handled at all, and that prospecting and development schemes would get no support. This is a misapprehension. There is no one who follows prospecting and development schemes all over the world with more interest than I do, or who realizes more their importance with regard to the future. But I draw a line. Blocked-out ore is a fact—the supreme fact in mining, and nothing else can balance it. If the investor wants reasonable security for his capital in mining he must buy ore-reserves, for it is their existence which differentiates the good from the not good. But I readily admit that some one has to take the risk of opening new mines, and that there are many ventures in whose earlier stages valuation and ore-reserves play no part at all.

If these ventures are conducted with discretion, and if those who advance the money for exploiting them know the risk they are

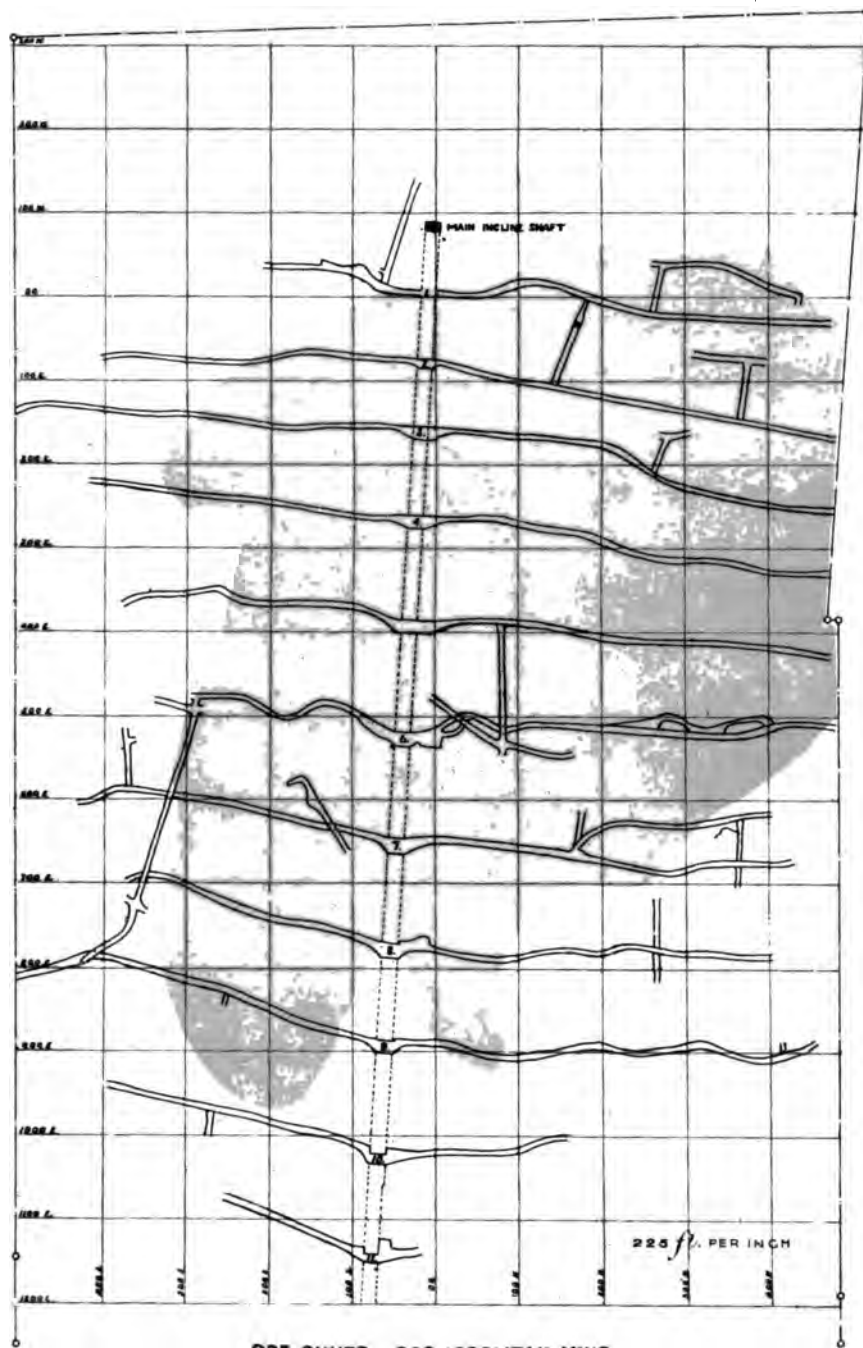
taking, there is much to be said in their favour. But I wish to state clearly that a mine with no ore exposed should only have a small capital, and that the vendors or promoters of such mine—with no security to offer—have no right to ask for or receive a big percentage of the shares.

I may state here that the present chapter may be held to apply to all the gold-mines of the world except the mines of the Witwatersrand. The theory of mine-valuation takes into account two unknown factors of risk—the existence of unseen ore, and the value of the same. On the Rand one of these factors of risk is eliminated, for there is no reasonable doubt of the existence of the ore. The other factor is partly eliminated, for the ore there always carries a certain amount of gold, and the only real question is as to whether the average gold contents reach a certain standard. It does not follow that Rand mines are exempt from a strict standard of valuation; but this is carried out on a different basis to the valuation of all other gold-mines.

I now pass from outlining the correct basis on which future flotations should be made to a consideration of the theory of mine-valuation as affecting mines already floated.

Here again there is just one thing which really matters—the ore-reserves; and the proportion of profit in sight in the ore-reserves to the market valuation of the mine is the factor on which everything should depend.

The aim of the investor in mines should be to know at all times the quantity and value of the ore-reserves, or their equivalent—the net profit in sight—in those he is interested in. With this aim in view, and also by way of technical precaution, it is advisable that managers of mines should be requested to furnish a statement about ore-reserves twice a year. These statements should be clear as to the quantity of ore, its average gross value, and the net expected to be won from same. With the yearly report



should be issued, showing the outlines of the pay ore, and the different blocks taken into his estimate. The half-yearly statement need not be so elaborate, nor need it contain a plan; if the developments for the period are described clearly, the shareholder should be able to fill them in for himself. It may be added that if the shareholder cannot master the detail of such reports and plans—which, once explained, are mostly easy of comprehension—he should not invest his money in mines. The shareholder should ask one other thing of his mine-manager—that he should be a member of the Institute of Mining and Metallurgy. I think the time is coming when the Institute will exact a high professional code from its members. When such time comes it will be a point of honour with a manager that, unless expressly stated otherwise to the shareholders, he shall at all times work to the best of his ability only what he believes to be the average value of his payable ore-reserves at that particular time.

The investor now having assured himself of the net profit in the mine, and of the appearance of the main points of development, has to systematize this knowledge and turn it to his advantage. We must suppose him as one to whom the making of money, or the safety of what money he already has, is a matter of moment; also a person of a reflective turn of mind. Such a man will not start out with the idea that money put into mines will accumulate of its own accord; rather, his reading on the subject will have brought home to him the uncertainty of ore-chutes, and the danger of assuming things about ore not yet exposed.

Based on the factor of the net profit in sight, I put before such type of man a system of valuation which has been found in practice to give good results. It refers, of course, only to producing mines.

It is as follows :—

- (a) The net profit in sight in the ore-reserves must be equal to two-thirds, or 66 per cent, of the market valuation.

E

- (b) The main points of development in the mine must show no material falling off in bulk or value of ore.
- (c) The yield on the investment must be 15 per cent.

These three factors are a basis; but they are susceptible of permutation to a certain extent. If, for example, instead of being 66 per cent, the profit in sight were 100 per cent, it is clear that the good appearance of the mine at all the main points of development is not such a vital matter, and a falling-off in value at some of these points might be noted without undue alarm. At this figure the investor is assured of getting his money back. All he risks is the interest on it, and it would take no great further amount of ore to make that good to him.

On the other hand, if the mine is looking downright bad in the bottom, or even shaky, the investor should not be satisfied with two-thirds profit in sight; and at a market valuation representing anything like this figure he should sell out. A mine is more likely to get worse in depth than to improve, and under such conditions he is not justified in risking anything like one-third of his capital. The yield of 15 per cent, the other two factors being satisfactory, is also needed. The investor of reflective mind will realize that his first duty is to redeem his capital, and that of the 15 per cent dividend he receives, at least two-thirds should be devoted—until the redemption is completed—to this purpose. He is therefore only receiving 5 per cent interest on his money until such time as his capital shall have been redeemed, and is not entitled to consider more than this as interest.

If, disregarding this rule, he lays out his money in mines which yield him 10 or only 8 per cent, as is frequently the case, these mines should have a profit in their ore-reserves of over 100 per cent of their market valuation, and assured prospects in depth. Only on this basis can he expect—besides drawing a 5 per cent interest on his investment—eventually to redeem his capital at stake.

It may be stated here that the mines yielding 8 or 10 per

their purchase price very rarely have such assured ore-reserves, and that this rate of interest should hardly ever be accepted as good enough from any quartz-mine.

On this basis of valuing a mine it will be noted that 66 per cent of the market valuation is to be in sight, and that this is to be repaid at the rate of 15 per cent a year, or, in other words, over a period of about $4\frac{1}{2}$ years. Under normal conditions, therefore, my basis of valuation entails $4\frac{1}{2}$ years ore-reserves blocked out ahead.

How does this tally with the purely technical working of the mine? A high authority has laid it down that, as regards cheap working, the economic limit of blocked-out reserves is equal to a three years' supply. If, on the head of this, I require a further $1\frac{1}{2}$ years' supply, no doubt an extra, though not large expense, is entailed; but I consider such larger reserve to be a necessary security, and look on the extra cost involved in the light of an insurance premium.

I am satisfied that this basis of valuation is the minimum of security which a producing gold-mine should offer. In round figures it allows for the risk of one-third of any sum invested, while the other two-thirds are secured by the ore-reserves. There is also a further implied security in the sound appearance of the bottom of the mine.

But the risk is really more than one-third, in so far as no allowance is made for interest on the capital at stake. If shares were bought on this basis, and the mine immediately afterwards went wrong, the investor would receive back two-thirds of his capital, over a period of $4\frac{1}{2}$ years; his loss would be one-third of his capital, plus interest on the whole of it for this period. There is still a further point. When a mine is coming to an end it is usual to spend a lot of money in prospecting for further pay ore—of course with no return. This money is got from the profits of the ore already exposed, and these will therefore be smaller than were calculated on.

Taking note of these points it is probable that my basis of valuation entails a risk of about half the capital involved.

The Chart I have prepared—judged on this basis of valuation—will show at a glance that most of the mines named on it are quite overvalued. Human optimism has got the better of knowledge and experience. In finding their true level of value a number of these shares will probably, sooner or later, fall rather heavily, and people who imagine themselves to be investors, and therefore exempt from such shocks, will call out loudly that gold-mining is a sham and a fraud. But gold-mining need be neither a sham nor a fraud to any one.

The investor looks to current dividends to guide him. These are a help in arriving at values but he has got to be taught that a proper estimate of the ore-reserves—in their relation to the mine's market valuation—is the real fact to grasp. If people neglect this fact they will, in the long run, lose by buying mining shares.

As a rule every man considers himself competent to invest in mines, but it is worth recording here that professional rather than amateur knowledge on this subject, as on all other subjects, is more likely to stand the test in the long run.

MARKET PRICE OF SHARES	NAMES OF MINES.	Market Valuation									
82/6	Mount Boppy										
30/-	Nundydroog										
20/-	Ooregum										
32/6	Globe & Phoenix										
17/6	Selukwe										
21/-	Esperanza										
20/-	El Oro O										
34/-	Camp Bird X										
157/6	Great Fingall										
27/6	Associated										
12/-	Perseverance										
22/6	Northern Blocks										
22/-	Great Boulder										
65/-	Oroya Brownhill										
B		Profit in Sight									
146/-	Kalgurli	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
167/6	Ivanhoe										
90/-	Gwalia										
160/-	Horseshoe										
20/-	Tomboy										
147/6	Alaska Treadwell										
135/-	Waihi										
57/6	Mount Morgan										
817	Oriental Con ^d										
137/6	Mysore										
35/-	Champion Reef										
A											

O Including Railway.
 X After deducting Vendors' rights.
 ✕ Valuing Copper at £55 per ton.

CHART

Showing proportion of Profit in sight to market valuation of various quartz-mines, with prices as in April, 1905.

The figures are arrived at from the last yearly reports of the mines.

Cash in hand is represented by a dotted line. Profit in ore-reserves by a thick line.

Column A contains mines which continue to look well in depth.

Column B contains mines which at present are doubtful as regards the future.

Examples.—Kalgurli: with shares at £7 6s., the proportion of profit in sight is 76 per cent, of which 7 per cent is represented by cash and 69 per cent by ore-reserves. Mine continues to look well in depth.

Selukwe: with shares at 17s. 6d., the proportion of profit in sight is 17 per cent, of which 7 per cent is represented by cash and 10 per cent by ore-reserves. Present aspect of mine in depth is doubtful.

CHAPTER V

THE GOLD-MINES OF THE TRANSVAAL

THE CENTRAL RAND

GOLD was first worked in the Transvaal in 1870. This was at Marabastad, in the Zoutpansberg district. In the following year alluvial gold was found at Pilgrim's Rest and Mac Mac, in the mountains above Lydenburg, which drew to this field for a time people from all over the world. The next landmark is 1884, in which year reef-gold was found in a number of places on Moodies' Hill, and all along the De Kaap range, and the town of Barberton came into being as the centre of a new quartz-mining field. The De Kaap district was never much of a success financially; but it served to draw attention to the gold-mining possibilities of the country, and was the headquarters from which many prospectors went out.

From 1886 onwards a series of discoveries, mostly of "banket," or conglomerate, was made. Witwatersrand, Heidelberg, Potchefstroom, and Klerksdorp districts were all found to carry these conglomerates. Explorers later on opened up the stratified veins of Lydenburg—from which the Pilgrim's Rest alluvial had originated—and the quartz-reefs of the Murchison and Klein Letaba fields. Less important finds were made in the New Republic and in Swaziland—now parts of the Transvaal—and at Malmani and Otto's Hoop, near the border of Bechuanaland.

Most of these fields have been unsuccessful. Some have not suffered from lack of capital, but since 1886, the

which the Witwatersrand field was found, they have played a relatively small part, as will hereafter be shown. The Rand, on the contrary, has already yielded over £120,000,000 sterling; it is the centre of a really great industry, which grows in size each year, and is, as a gold-field, probably equal in gold contents to all the other known gold-fields of the world put together.

The origin of the conglomerate, or banket-beds, of the Transvaal, of which the Rand forms a small portion, and of the gold in them, are questions which geology has not yet finally answered. It is thought that the beds themselves were formed on the beaches, or bottom, of an inland sea; and as for the existence of the gold, the highest authorities believe that the bulk of it was added subsequently by the infiltration of metal-carrying solutions.

The area of the basin underlaid by the conglomerates embraces most of the Southern Transvaal and Northern Orange River Colony, and the outer edge, or rim, when eventually traced, will no doubt be found to extend for quite four hundred miles. Evidence is accumulating to show that this basin, huge as it is, is only a portion of the conglomerate-carrying area. Underlying the banket formation is granite, and here and there, outside the area of the main basin, masses of this rock are exposed. Round these granite "bosses," which have been forced up, are found in places the broken edges of the displaced banket formation; and there is reason to think that the banket areas found near Bloemfontein, at the Swaziland border, at the Kantoor, and in Zululand—their tilting up being no doubt due to the action of the granite—are all parts of one great bed.

If the whole, or even one-half, of these supposed vast conglomerate beds were found on further exploitation to lie at a workable depth, and to carry payable gold, a gold-field one hundred times as large as the present Rand would come into being. I am glad to know, however, that there is strong evidence against such a condi-

tion of things; for if gold existed in such concentrated quantity, there would be practically no limit to what the Transvaal could produce, and the finance of the world would become disorganized.

The evidence to date about these great blanket-beds is that they are usually of no commercial value. In many places the blanket exists as a mere vein on the contact, while over big areas a width of not more than an inch or two is the prevailing thickness. In other parts, where a width of several feet is shown, the gold contents are poor. Outside the main basin, so far as I know, no payable blanket has been found as yet. There are in the main basin—but outside the Rand—patches every here and there which will pay to work; these in the aggregate may eventually amount to a relatively large addition to the area now looked on as payable.

To date all evidence goes to show that there is no other section of the conglomerate-beds which can be compared to the Rand for width of ore and gold-values; to all intents, although part of a much vaster system, the Rand beds can therefore be treated as a separate gold-field. When the outlying areas have been more fully tested and developed, certain sections in them may be found to rank as of equal stability with the Rand, but until such proof is to hand too strict a line of cleavage cannot be drawn.

The Witwatersrand field proper may be considered as extending from Boksburg to Randfontein, a distance of about forty miles. This, as I have shown, is only a relatively small section of the basin. In the last year or two a number of boreholes have been put down on each extension of this section, with surprising results. On the east, beyond Boksburg, the reef has been traced right round to Heidelberg, and the existence of a large new gold-field demonstrated; this rim of the basin will in due time be traced over the Vaal River into the northern part of the Orange River Colony. On the west, boring has already shown the reefs twelve miles Randfontein, and further exploration will no doubt link

western extension with the Klerksdorp field. Payable patches of ore have been located at each of these extensions.

The yield of gold from the Rand, to the end of 1904, totals £114,572,393, made up as follows:—

	£
1887	81,022
1888	726,821
1889	1,300,509
1890	1,735,491
1891	2,556,328
1892	4,297,610
1893	5,187,206
1894	6,963,100
1895	7,840,779
1896	7,864,341
1897	10,583,616
1898	15,141,376
1899)	14,414,907
1900)	
1901	1,014,687
1902	7,179,074
1903	12,146,307
1904	15,539,219

Given sufficient labour, the yield should steadily increase to over £30,000,000 a year, and under certain conditions might be expected to reach a high-water mark of over £40,000,000 a year. For the next fifteen to twenty years, from the Rand proper, an average yield of over £30,000,000 seems not improbable.

It would but be guessing to hazard an estimate of how much gold the Rand will yield from first to last, for the factors on which such an estimate should be framed cannot be arrived at with any exactness. Even in the shallower parts of the Rand the average value over many sections is not really known; while such vital factors as

the persistence of average values to great depths and the limits to which mining will be commercially profitable cannot be arrived at for years.

Estimates of the yield have been made varying from £700,000,000 sterling, mining to a vertical depth of 3500 feet, up to £2,871,000,000, mining to a vertical depth of 6000 feet. It seems certain that the actual figure will eventually be found to lie between these extremes.

I believe it a safe estimate to say that the blanket-beds of the Transvaal will produce not less than £1,000,000,000, and that the great bulk of this will come from the Witwatersrand.

An estimate has been made that, down to 4000 feet vertical, there are 40,000 claims on the Rand, and it is calculated, further, that each claim exhausted to date has yielded about £65,000. It is not to be inferred from this that the whole Rand will be worked to a depth of 4000 feet, nor is it to be taken that the remaining 38,000 unworked claims will on the average each yield £65,000. Up to the present the richest parts of the field have been worked, and the poorest parts left unworked; it is more than likely, too, that large areas of the Rand will never be worked at all, so that on figures of this sort no real estimate is possible.

Taken as a whole the Rand, as already stated, is probably equal in gold contents to all the other known gold-fields of the world. Compared, too, with other known areas of the conglomerate-beds it is infinitely better. But I cannot too strongly emphasize the fact that the Rand is not a field of the exceptional regularity it is supposed to be. Both in width of ore and in values, to say nothing of broken and faulted ground, there are considerable variations from one end to the other, and to assume, as is so often done, that any given mine or area is valuable because a neighbouring mine is—to assume this by inference, rather than on actual results of development, is quite unjustifiable.

Where a gold-field is capitalized at over £150,000,000, as the

now is, there is no room for haphazard methods of valuation, and I shall do all I can to expose such. Gold, whether in the Rand conglomerates or elsewhere, is a highly capricious metal. The more one knows about it, the less disposed is he to take risks ; and it may be here laid down that the empirical system of mine-valuation which has so long existed on the Rand has got to be altered very materially in the days to come.

I shall now briefly describe the mines on the Rand—from Boksburg to Randfontein, beginning with the outcrop mines.

The **Boksburg** mine has an area of over 1100 claims. On this ground ten bore-holes have been sunk, cutting the reef at depths varying between 100 and 1400 feet. All of these gave poor results, and the prospects of the mine are not good.

The **New Blue Sky** has an area of 40 reef claims. The ore here is narrow, but is probably payable. This mine is controlled by the East Rand Proprietary Company, and will be refloated as part of a larger concern.

Cinderella has 16 reef claims, of probably payable value. This mine, together with the New Blue Sky and the East Rand Proprietary's deep level ground, will be refloated into one large mine.

Cason Gold Mines owns over 200 reef claims, and has a large amount of ore exposed. A mill of 220 stamps is being erected. The ore in this mine is considerably above the average of the field, and if it were to continue so throughout the area of the mine the large resulting profits would justify the shares standing at a good deal more than their present price of $5\frac{3}{4}$. It is safer, however, to assume in the meantime that the unexposed ore will not carry such exceptional value ; but, in any case, the shares seem to be worth their price.

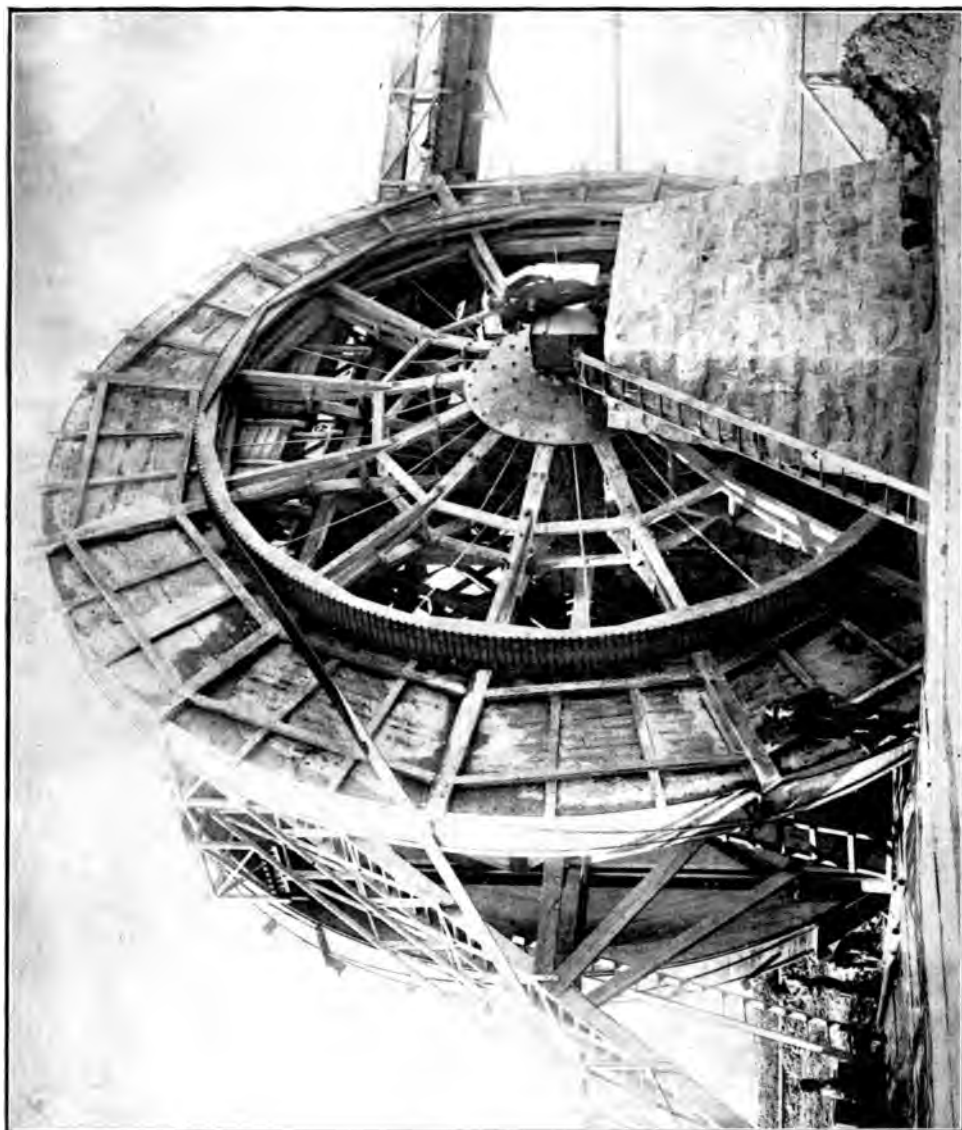
New Comet, Angelo, Driefontein. These are three subsidiary mines of the East Rand Proprietary Company, and are now producing. It is intended to provide them with 150, 220, and 220 stamps respectively. On this basis the lives of these mines, from 1906, should be something between twelve and fifteen years. These are good mines; but taking note of their moderate lives and making due allowance for redemption of capital—the shares at £3, £7, and £5 respectively appear to me to be rather over than underrated.

Ginsberg. A good deal of low-grade ore is being exposed in the lower levels, and it is unlikely that the present average value can be maintained for the life of the mine. From 1906 the present mine should last for about four years, but it is not certain that the present rate of dividend will continue. North of the dyke, on the faulted section of reef erroneously called the "North" reef, some payable ore will probably be found, and the life of the mine increased; but the extent of this faulted section is hard to gauge. At $2\frac{1}{2}$ the shares seem to be overvalued.

Witwatersrand. This mine owns considerably more than 400 reef claims, but owing to their location will not be able to work more than half of them conveniently. The rest will, no doubt, be absorbed by adjacent deep-level mines. The company receives over £12,000 a year as freehold owner of the farm Driefontein. There are 200 stamps.

The past history of this mine shows it to be especially low-grade. No doubt with 200 stamps it will now earn large profits, and the estate and the deep-level claims are assets of considerable value; but I am inclined to think that the present market value of the mine—over £2,500,000—has discounted things liberally.

Glencairn. This mine has fallen off in value from its earlier average. It is not possible to know whether the undeveloped area is likely to show improvement. Should it not do so the shares, at their intrinsic value, are not worth $1\frac{3}{4}$ their present price.



TAILINGS WHEEL—DRIEFONTEIN 220-STAMP MILL

May Consolidated, unlike most outcrop mines, has improved rather than deteriorated with depth. From January, 1906, the life is estimated to be not less than eight years. Allowing for redemption of capital the shares at £4 are dear enough.

New Primrose. It has been stated officially that the life, from 1906, is about nine years. I consider it unlikely that all the ore yet to be treated will yield as much as the present figures. Allowing for redemption of capital, the shares seem fully valued at over £3.

Simmer & Jack is a low-grade mine. There are about 300 unworked reef claims, and at 40,000 tons a claim the unworked ore, as from the beginning of 1906, may be figured at 12,000,000 tons. The capital is £3,000,000. At the time of writing the shares stand at £2, thus making the market value £6,000,000. If shareholders in this mine will take the trouble to go into figures, they will find that to redeem their capital and give them 7 per cent interest on their investment each ton of ore remaining in the mine will have to yield a net profit in the neighbourhood of 20s. So far as can be seen, there is no probability of the ore yielding such a profit.

The market value of this mine, as with a number of other Rand mines, bears no relation to its intrinsic value. The bulk of the shares are held by a finance company, and that company, for its own ends, supports the value of Simmer & Jack shares at this inflated level. This method of mine-valuation must do harm to the Rand in the long run.

Geldenhuis Estate has probably less than a million tons of ore remaining, and on this should earn nearly £1 a ton profit. The life from 1906 is not likely to exceed five years. There will then remain an estate which should be of some little value. The shares at £4½ seem to be fully priced.

Treasury. From 1906 this mine's life is put, officially, at eleven years ; but no doubt, as in so many other cases, the average value of the ore will fall somewhat. After allowing for redemption the shares, at £4, look to be overvalued.

Jumpers. The ore remaining in this mine is of low value, and during its life of, perhaps, two or three years the profits will not be material. The main asset is a holding of 25,100 Jumpers Deep shares. Should the Jumpers Company acquire title to its 28 Bewaarplaats claims, it is under agreement to surrender these to the Jumpers Deep for a further 36,662 shares ; but the cost of acquiring these claims must be written off their net value.

The **New Heriot** mine, in the lower levels, has met with poorer ore, and the present indications are that this poorer ore extends through most of the lower parts of the mine. The western section of the mine is now being more actively exploited, and it is probable that a new shaft will have to be sunk here, at a cost of £50,000. Under present conditions the life of the mine, from 1906, might be six or seven years ; but it is suggested that a piece of the Nourse Deep ground shall be acquired and the life lengthened. It is difficult to estimate what future profits will be.

Henry Nourse. In October, 1904, it was officially stated that the unworked ore was 1,650,000 tons, of which an appreciable portion was of very low value. It was also stated that the grade of ore to be treated in the future would be lower. To meet this anticipated falling-off, £120,000 was to be spent in increasing the plant. The increased plant will be able, by treating more ore, to keep up the old rate of profit ; and for seven years more, from 1906, the old high rate of profit should be earned. Other assets held by the Henry Nourse Company are 14,000 Wolhuter Deep shares and 35 Bewaarplaats claims. The latter are, prospectively, of considerable value. Allowing for redemption of capital, these shares see priced. An amalgamation with Nourse Deep would be ad

New Goch. It is proposed to erect 60 more stamps, making, together with those in use, 120. Provision must also be made to raise, probably, over £400,000 to cancel the debt. This is a disappointing section of the Rand, and with a mine such as this speculations as to the value of unexposed ore are not justified. The mine is valued at over £1,000,000. On the top of that, by the time 120 stamps are at work, there will be a debt of £400,000. These figures seem far too great for a mine of such uncertain tenour.

New Spes Bona is a poor mine. It is of small area, and is saddled with a debt of something like £200,000. I believe the Wolhuter Company had the mine valued, with a view to acquiring it, and as the result made an offer of £20,000.

Wolhuter is also poor, and its future prospects are not quite satisfactory. For these three poor mines, Wolhuter, Spes Bona, and New Goch, I advocate amalgamation. I would also include the adjoining **Meyer and Charlton** in the group. This mine earns good profits, and has a life from 1906 of about six years; but it could be worked to better advantage as part of a larger concern. The control of this group of mines might be placed in the hands of those who are already in control of Meyer and Charlton and New Goch; and the amalgamated mines, with one board of directors, and one management, instead of four, as at present, and with one general scheme of development, might pull these poor mines out of the mire. Unless this is done I don't believe the three first-named mines will do any good to speak of, while the short life of the Charlton detracts from its intrinsic value.

City and Suburban. The ore in this mine has been showing poorer with depth, and an estimate of the value of the unexposed ore in the lower levels is not justifiable at present. It is proposed to divide the lower part of the mine, which could not be conveniently worked under the present scheme of development, between the

Village Deep and City Deep mines, for which shares in these two companies would probably be received. The company's township site is of some value. City and Suburban shares should not stand at over £5.

The **Jubilee**, according to official figures, had 243,000 tons of ore remaining at end of 1904. I believe most of this is of low grade. Other assets at that date included: (a) Cash £31,000; (b) Shares worth £10,000; (c) Slimes; (d) $4\frac{1}{2}$ Bewaarplaats claims; (e) Some freehold property, jointly with Salisbury Company; (f) Surface plant so located that it can probably be sold to a deep-level mine.

The **Salisbury** is estimated to have a life of three years from January, 1906, and might earn £1 a share over that period. Other assets are: (a) 19,000 South City shares; (b) Two deep-level claims; (c) Two small water-rights; (d) Slimes; (e) Freehold property; (f) Surface plant, so located that it can probably be sold to a deep-level mine. These two mines should be amalgamated with the City and Suburban or Village Main Reef.

Wemmer. The official statement with regard to this mine's life is five years, as from beginning of 1906. In addition to this asset the company owns: (a) 34,926 Village Deeps; (b) 11 Bewaarplaats claims; (c) Water-right. The mill and surface plant of the Wemmer is so located that when the mill is worked out this can probably be sold advantageously to one of the deep-level companies. At $9\frac{1}{2}$ the shares seem to be over-valued. It is proposed to amalgamate this mine with Village Main Reef.

The **Ferreira** is estimated to have a life of ten years from 1906; but the grade will probably fall slightly, and an exact estimate of the mine's profits over that period cannot be arrived at.

There are also 25 claims, in several different blocks, held as water-rights and Bewaarplaats. These are all very valuable. Their acquisition from Government, on terms, would be an

big prospective value. Ferreira shares, like most other Rand shares, appear at over £20 to have fully discounted the future.

The **Robinson**, despite a gradual falling in grade, has opened out well in depth, and as an average width of 81 inches is being mined, the ore contents are turning out better than was looked for. The mine will, no doubt, last for from ten to fifteen years, as from 1906, but the shares at £10 seem over-valued.

Bonanza. This mine should be exhausted early in 1906. It is possible that the worked-out mine, including the untouched ore of the Main Reef, may be acquired by an adjoining mine; but as this ore is only found to assay 12s. a ton, the price to be received will be small. The surface plant may also find a purchaser at a figure.

Crown Reef is estimated to have a life of four to five years, as from the beginning of 1906. It is supposed that the remaining ore is of almost equal value to that now being mined.

In addition to the outcrop mine, there are 51 deep-level claims and about 45 Bewaarplaats. The whole of these, should the title to the latter also be secured, will be incorporated in the South Rand Company, and represent a very valuable asset. Furthermore, the reduction plant of the Crown Reef is located on these claims, and should they be thus incorporated with the South Rand, that company will find it advisable to take it over at a substantial figure. The interests of the two mines are so far identical that, assuming title were secured to the Bewaarplaats claims, I consider an amalgamation would be advantageous. Crown Reef shares at £15 appear to be over-valued.

Langlaagte Estate. In addition to its mine, this company has 700,000 tons of slimes worth 2·7 dwts., which are now to be treated; it also holds a large interest in the Block B, the Consolidated Langlaagte, and the Langlaagte Exploration Company. It is difficult to put a precise value on Langlaagte Estate shares.

Langlaagte Royal. The outcrop block of this mine should be absorbed by the Langlaagte Deep, and the deep-level block by the Paarl Central Company. There is a very large debt.

Paarl Central. This low-grade mine should absorb the deep-level block of the Langlaagte Royal, and should then, in turn, be absorbed into the Langlaagte Deep. The latter, with its fine organization and equipment, and by increasing its mill to 400 stamps, could work this ground to great advantage.

Langlaagte Proprietary is a low-grade mine, held privately by French owners. It is at present shut down.

Langlaagte Block B is poor, but probably payable. The deep-level ground should be taken in, and the plant increased. There is an asset of Langlaagte Proprietary shares. No definite price can be put on Block B shares.

Langlaagte Consolidated. A low-grade mine, which cannot be even approximately valued as yet.

Consolidated Main Reef. A low-grade mine of big area, with large holdings in two subsidiary deep levels. As against these there is a big debt. Profits are being earned, but no definite value can be attached to the shares.

New Unified is poor. It may, or may not, earn profits, and no real value can be given to the shares as yet. The same remarks apply to **Aurora West United**, which, however, is probably the better mine of the two. Nothing is known of the deeper portions of the Rand along all this section, and a mine such as the Main Reef, Unified, or Aurora West, which to-day, perhaps, shows payable results, may five years hence show nothing but unpayable ore. I look on the section of the Rand between Langlaagte Es United Roodepoort—a distance of eight miles—as of

value, and the shares of the mines along this section are quite speculative. In course of time no doubt a good deal of the ore will be worked at a profit, but the margin can hardly be a big one, and may vanish when an average depth of 1500 or 2000 feet is reached.

Bantjes, Vogelstruis Estate, and Roodepoort are also within this poor section. These are all large properties, and if treated on a big scale may earn fair profits in the shallower levels. Until they have been explored at depth, however, I will not venture to vouch for their profits at a more remote period. These shares are all speculative.

The **Roodepoort United** has from 1906 an estimated life of eight years. A prospective asset of value is also owned in the shape of 78 claims below the Durban Roodepoort Deep, and a further block of water-right claims. The shares seem dear at their present price of £3.

Durban Roodepoort. From January, 1906, the life of the mine on the present high grade of ore is figured at not more than three years. There will then remain eighteen months' work on ore yielding, say, 27s. 6d. a ton, and producing a relatively small profit. After that the mine will only have its main reef to fall back on: there is a lot of this which will assay 16s. a ton, but I don't expect it will show a profit. These shares are greatly over-valued at £5.

Princess Estate is a badly faulted mine. The reef, though very narrow, is of fair value, but no estimate of the future is possible. The freehold estate produces revenue of £8000 a year.

Roodepoort West is a small, badly faulted mine, located where the reef series is broken off. It is probably of no value. The **Saxon** is also in disturbed country and of doubtful value. From here the reef is faulted some miles to the north-west. The continuation is

picked up on **Grey's Mynpacht**, which is faulted and of low grade. Next to this is the **French Rand**, a property of 400 claims. This mine is irregular in value, and will not show good profits unless worked on a big scale. Meanwhile, there are only 60 stamps and a heavy debt, so that re-organization, of one sort or another, is indicated. No definite value can yet be placed on French Rand shares.

Champ d'Or. The life of this mine is now very limited. There is an asset of slimes yet to be treated.

Windsor is a poor mine at present, although some years ago it looked well. No estimate of the future is possible.

Luipaard's Vlei is low-grade, but if worked on a large scale may earn profits. There is a large area, but the true average value in it is not yet known.

The **York** is a small, poor mine, with doubtful prospects.

West Rand Mines is not yet proved to be a payable mine; but its large area, the big working capital provided, and the great scale on which it is proposed to work, together with the fact that it may have the makings of a permanently profitable mine, render it quite an interesting problem. No definite value can be placed on the shares yet.

West Rand Central is a small mine, and does not earn much profit. The official estimate of life is five years from 1906.

Under the title of the proprietary company, I shall discuss the prospects of the subsidiary **Randfontein** Mines. These twelve companies are situated together along a stretch of six miles, at the extreme west end of the Rand. The reefs have been traced through all this area, and are here found to be steep and

It seems to me, taking this section as a whole, that,

narrowness of the reefs, they should yield good results, and in the future, although not the near future, we may expect this section of the Rand to produce largely.

Serious factors have to be faced in the meantime. Foremost among these is the question of finance. Out of the twelve mines, six have not yet received working capital, and the expenditure on the other six is not completed. The four producing mines, having spent their original working capitals, are in the aggregate £800,000 in debt to the parent company. I suppose that to pay off this debt, and to bring the whole twelve mines to their full capacity a further expenditure of between £3,000,000 and £4,000,000 must be made.

If, as has been stated, these twelve mines are to be further subdivided, the total expenditure will be enormously increased.

The next factor is to ascertain the true value of this section of the Rand. This is not known yet, and the system of valuation now in force will not admit of the right figures being arrived at. The four producing mines publish frequent statements as to the quantity and value of the ore-reserves; but in practice these figures are not reached, and many people wonder why. The figures given out by the management exclude all ore under 33s. assay value, and it is assumed that no ore of lower value than this will be mined. But it is not possible, in my humble opinion, to value mines in this way; and I feel sure that ore of less value—let the management do what it may to prevent it—is continually being sent up from all these mines. This is borne out by the results of actual work. I imagine that if the management tries to run these mines to an artificial grade of nearly 40s. a ton, and bases its estimates of profits on such, there will be a series of disappointments, whereas, if content to average a little over 30s. a ton, all these mines may in the long run be fairly successful.

On the whole, I expect the Randfontein section to be a success; but I do not look for this for some years to come, nor until a great deal of money has been spent. It would be a matter of difficulty to place definite values on any of these shares.

Randfontein Deep. As a deep level of the Randfontein area this mine lies probably below the 4000-foot limit. A borehole sunk to 5000 feet passed through a number of reefs, but none showing payable value. The immediate prospects of the property, which is a very large one, rest in the several reefs which outcrop in it. Some of these are at present giving good results, and the mine is on this account worth watching.

The deep levels of the first row, as I define them, are those whose vertical shafts cut the reef at less than 1500 feet. Beginning at the Boksburg end of the Rand, the first of these is the **East Rand Extension**, which is the deep level of the Boksburg Company. Two boreholes were put down on this ground. No. 1 struck the reef at 1355 feet, and showed 42 inches of ore; and No. 2, at 1475 feet, showed 25 inches. In each case the assay value is reported as being over £6 a ton. This is strange. The ten boreholes on the Boksburg mine all showed unpayable results, and the several other boreholes sunk in the neighbourhood were also poor. Pending the sinking of shafts to check these figures, I venture to doubt their correctness, or at least to doubt whether any large patches of such rich ore exist in this locality.

The next first-row mine is **Witwatersrand Deep**, a large property, with 200 stamps. Basing an estimate on its present ore-reserve, this would look to be a mine above the average. My idea is, however, that its present reserves are richer than the average ore in the mine, and that the west section, which has so far been the richer, will, below the dyke, be found to fall away in value. It is therefore too soon to make calculations about the unexposed ore in this mine.

Knight's Deep. This mine has not turned out so well as was at one time expected, while the heavy flow of water met with has altogether upset the financial arrangements. There is a big debt; this must be cleared off, and 200 stamps started, before the mine can begin to make profits commensurate with its capitalization. In the meantime the shares cannot be correctly valued.



EXAMPLE OF FAULT AND DYKE IN NOURSE DEEP MINE

The **Glen Deep** looks well, and with a plant equivalent to 200 stamps will earn good profits. The average grade of the mine cannot be arrived at till returns are made by the mine below it—the Simmer East. It is, however, possible that the lower section of Glen Deep will not show such good results as the upper levels.

The **Rose Deep**, as its lower workings approach the Simmer East boundary, seems to show a marked fall in value. Old estimates as to this mine's profit-earning capacity have had to be revised.

The **Geldenhuis Deep** continues consistently good, and has exceeded expectations. Valuable evidence as to the lower part of the mine will now be produced as the result of developing the Simmer West and Jupiter, and before long an approximate estimate of the total ore in the mine, and its value, will be possible.

Jumpers Deep is of lower grade than was expected, but worked with 200 or 300 stamps should do fairly well. The favourable developments in the mine below this, the Jupiter, give extra stability for the future.

Nourse Deep. The prospects of this mine are better than they were some years ago, when very broken ground was being met with. Pending the result of development in the mine below—the South Nourse—no definite valuation can be arrived at.

Village Main Reef is estimated to have a life of twelve years from 1906; and allowing for redemption of capital and 6 per cent interest, the shares are figured out as being worth £6. The value of 20,000 Wemmer shares held is included in this. This price may be taken as a maximum valuation.

The **Ferreira Deep** is another example of a great mine, greatly capitalized. At a market valuation of £5,500,000, I see nothing to be gained in buying the shares. With 200 stamps at work, this mine has a chance of becoming the biggest gold-producer in the world.

Robinson Central Deep has 45 claims, of which 7 are in dyke, leaving 38 reef claims. As from 1906 there should be 1,750,000 tons left in the mine, or a life of ten years for 100 stamps, it seems probable that the net earnings will average 25s. a ton all through, and allowing for redemption of capital and 7 per cent interest, the shares are worth round about £4.

Crown Deep is a fine mine, but, taking redemption of capital into account, would appear to be over-valued at £15 a share.

Langlaagte Deep, although a low-grade mine, gives promise of being successful. The prospects appear to justify the erection of 200 or 300 more stamps, and the absorption, if it can be arranged, of the Langlaagte Royal and Paarl Central into one big unit. Of course there is still a big debt to be paid off, and it will be some years before the mine reaches its maximum capacity. In the meantime the shares can hardly be valued with accuracy.

Langlaagte Block B Deep is a small property of 54 claims, as yet unworked. It should be amalgamated with the Langlaagte Block B.

Durban Roodepoort Deep promises to be a successful mine; but some sort of reorganization by which the debt is cleared and provision is made for a total of 120 or 150 stamps will no doubt first take place. A consolidation with adjoining mines into one 300- or 400-stamp unit seems economically justifiable. The shares at £3 seem fully valued.

Roodepoort Central Deep, as a mine, is an interesting problem. It is not a cheap mine to work, and on the present basis, working with fifty stamps, the net profits promise to be small. But the ground is probably good, and if it were worked to economic advantage—that is, not as a separate mine with a heavy managerial cost and mill but as part of a larger concern—it would give relative

better results. I think the proprietors of this mine should consider this question. In the meantime the shares cannot be valued definitely.

West Roodepoort Deep is in a disturbed locality, and, so far as exposed, the ore is poor. Exploration in the adjoining mines may indicate where better patches of ore are, and absorption into one or other of these may be economically this mine's best course.

The **Lancaster** and **Lancaster West** mines, as well as being deep levels of the main reef, work the Battery reef also. Not much is yet known of this section of the Rand, but so far as can be seen a considerable percentage of the ore here seems to be payable. Each mine has to get rid of a large debt, and on the head of that has to considerably increase its plant before it can earn such profits as justify the present value of the shares.

The **Violet** also carries two lines of reef; but here still less is known of the average gold contents. No doubt this mine should eventually earn profits, after years of development and a very large expenditure. The large area of the mine is a favourable feature. At £3 the shares seem over-valued.

The same remarks apply to the **West Rand Consolidated**.

The second row of deeps I define as those whose shafts cut the reefs between 1500 and 3000 feet. Beginning again at Boksburg, the first of these is **East Rand Deep**. Here a bore was sunk which at 2530 feet cut 45 inches of ore of a value of about £1 a ton. Little is known of the average value of the ore in this section of the Rand, and there are as yet insufficient data on which to assign an approximate value to these shares.

The **Rand Nucleus**, in the same locality, has put down two bores. No. 1 cut the reef at 1600 feet; 1 inch of ore assayed over £6 a ton, the rest of the core being lost. No. 2 cut the reef at 2246 feet;

4 inches of ore assayed about £2 17s. a ton, and here, too, some of the core is supposed to have been lost. Considering the width of the reef, these figures are poor, but in the meantime may be looked on as inconclusive.

Knight Central has 445 claims. In the report for 1903 it is stated that an area equal to 11 claims had been explored. The result showed 108,000 tons, worth 33s., and 121,000 tons, worth 24s. On these figures no profit could be gained, for the small profit secured on the better class of ore would be lost in the development of the poorer ore. It may be said that as yet the future of this mine is uncertain.

Simmer East. The value of this mine is not really known yet. Patches of unpayable ore occupy a considerable part of the area already explored. The percentage of such poor areas to the total area, and the cost of developing large blocks of unpayable ore, are factors that must be taken into account before any approximate valuation of the mine can be made.

The same factors must be applied to **South Rose Deep** and **South Geldenhuis Deep**. It is not to be inferred that all these mines may not eventually be successful; but there is good reason to think that they will be found patchy, and until much more is known about them no attempt at valuation would be justified.

South Nourse Deep. Indications of the value of this mine can be got from the workings in Nourse Deep and Jupiter. These are on the whole favourable, but until the mine itself is developed, no valuation can be made.

Wolhuter Deep, judged by its outcrop mine, is of doubtful value. Before work commences here this property will most likely be absorbed in a bigger concern.

City Deep is located in a favourable area, but nothing is yet known as to the value of the ore. The mine will probably be included in an amalgamation.

Village Deep, on its locality, ought to turn out a good mine. The ore exposed to date is of lower value than was expected, but on the whole is fairly good. Eventually, with 300 stamps, the mine ought to justify a capitalization of £6 a share, but that assumes no further falling off in value.

Robinson Deep is one of the few mines that have improved of late years. This improvement refers more to the width of ore than to its value, as the value is a good deal lower than that of the mines above it. The area explored up to date is producing about 64,000 tons a claim. From 1906 there should be about 175 claims to work, or, say, 11,200,000 tons. What the unexposed ore is worth can only be guessed, but it seems a maximum valuation to assume that these 11,200,000 tons will yield a net profit of £10,000,000. As this is already capitalized, at the time of writing, at over £6,000,000, an actuarial calculation will reveal the fact that the shares are standing at a full price.

Main Reef Deep, Main Reef East, and Main Reef West are on the dip of low-grade mines, and as yet nothing is known of their value. A borehole sunk on the Main Reef West cut, at 2032 feet, 15 inches of ore, worth 12s. 6d. a ton, and at 2039 feet, 46 inches, worth 12s. 6d. No estimate of the value of these mines is possible.

Vogelstruis Deep has been explored to some extent, but the ore exposed as yet has hardly been payable.

Tudor. On this property five bores have been put down, cutting the reef between 1600 and 2400 feet. One was in broken ground, where no reef was found, but in the other holes considerable widths of ore were cut. Two of these showed poor results. The third showed 28 inches, worth £2 10s. a ton, and the fourth 65 inches, worth £1 11s. a ton. The prospects are fair, but any definite valuation is not yet possible.

On the **Rip** two boreholes have been sunk. At 2039 feet a narrow reef was cut, showing low values, and in the other hole, at

3443 feet, 10 inches of ore assayed £2 10s. per ton. Judgment must be suspended till the shafts have got down.

The third-row mines I define as those whose shafts cut the reef between 3000 and 4000 feet. I look on these mines as located at a very interesting depth. I think it doubtful whether, with rare exceptions, any deeper shafts than these will be sunk; and the owners of these shafts will therefore acquire a big influence on all the ground lying below them, which in course of time may be worked by a series of inclines from this row of vertical shafts. I cannot pretend to name the precise depth below which technical, and more especially financial problems, will tend to make vertical shaft-sinking almost out of the question; but experience up to the present indicates that this already sunk and projected row of shafts, at somewhere about 4000 feet vertical, is that depth. I would not hold a share in any deeper mine than this.

Cinderella Deep is the most easterly of this row of mines. Its location is favourable. A borehole cut the reef at 3309 feet, showing 49 inches, worth £1 17s. a ton. Opening out the ore will commence at an early date; in the meantime, accurate valuation is not possible.

Angelo Deep is well located. Two boreholes showed poor results, but no accurate estimate of value is yet possible. There is a large area, and the company is well supplied with working capital.

Driefontein Deep. This mine is located in a doubtful area. It is probable that the reef lies at rather over than under 4000 feet. No estimates of value can yet be made.

Simmer West. I inspected this property in the early days of development, and found the reef to be much broken up. Where undisturbed it is a large body of ore, carrying, I was told, fair values. Until the mine has been fully explored, and the extent of ground estimated, no valuation is possible.

At the same time I inspected the **Jupiter**, also in the initial stage of exploitation. Here the reef was more regular, and was stated to be payable. This was at a vertical depth of 4000 feet, which at the present time is the deepest gold-mine in the world. It is not to be inferred that all Rand mines will be payable at that depth. Not enough work has yet been done on **Jupiter** to finally determine its value.

South City and **South Wolhuter** will no doubt be absorbed into the companies above them, as will **Klip Deep** and **Suburban Deep**. Worked alone, these latter mines would require shafts more than 4000 feet deep.

South Rand, when developed, should be a good mine, although no estimate of its actual value is yet possible. The remarks about Crown Reef apply also to this mine.

The **Steyn Estate** is located on the dip of several of the Roodeport mines, but in rather a doubtful locality. No work has yet been done, although the company has plenty of money.

South Randfontein Deep. A borehole was sunk, and at 3169 feet cut 23 inches of reef, worth £1 9s. a ton. This ground is well located, but the small area of 120 claims does not justify it being worked by itself.

The Rand companies owning ground in which the reef lies deeper than 4000 feet are to my mind not worth noticing. Even if the ground itself is payable at that depth, which is quite doubtful, it would be seven or eight years before profits could be earned. Is the investor prepared to lock his money up for that period, and take his chance at the end of it? Who, moreover, is going to be responsible for financing mines which will each require at least £1,000,000 to set going? As I have said, I believe the 3000 to 4000 foot row of shafts will hold a lien upon all this deeper ground, and most of it will eventually be incorporated in the companies owning these shafts.

These ultra-deep mines are: **Eastern Gold Mines, South East Rand Deep, South Knights, Rand Victoria East, Rand Victoria, Rand Mines Deep, Consolidated South Rand Mines Deep, Randt Reefs, South Village Deep, Turf Mines, Bantjes Deep, and New South Rand.**

In addition to the mines already enumerated there are on the Rand a number of companies the shares of which are still held in a few hands. In course of time these will, no doubt, be introduced on the market. Of these semi-private concerns, which are all deep levels, those really well located are **Hercules and Booysens.** The rest are mostly poorly located, and are: **Leeuwpoot, Leeuwpoot Deep, Rand Central, Hercules Deep, South Cinderella Deep, South Angelo Deep, South Simmer East, Elandsfontein Deep, Elandsfontein Estate, Vierfontein, Turffontein, South Deeps, Great Britain, Vlaktefontein, French Rand Deep, South French Rand, and South West Rand Mines.**

CHAPTER VI

THE GOLD-MINES OF THE TRANSVAAL—(*continued*)

PROBLEMS OF THE CENTRAL RAND

“As far as it is possible to foresee, about eighty millions sterling are still required for this colony by the government, various municipal bodies, and for private enterprise. I include in this figure the unissued portion of the Development loan, the thirty millions contribution, the requirements of the Water Board, and the Johannesburg and other municipalities, as well as a very large percentage of what our engineers consider will still require to be spent on the full development of these fields. To obtain this money we shall require the fullest possible support of the money-markets, not only in England, but also in France and Germany, and we must be prepared for a careful scrutiny of our position and prospects. Of course, the investment of this amount of capital will be spread over a considerable number of years. Provided developments are satisfactory, I do not think there will be any insurmountable difficulty in securing it. But our expenditure and revenue, as well as our taxation, will be most minutely gone into by financial experts every time we desire to place government or commercial stocks or shares of mining ventures, and we should endeavour to be able to present a clean record in every direction.

“We cannot expect the resources of wealth in the world to be placed at our disposal unless we are prepared to offer fair security for the capital, and a sufficiently attractive annual return to induce the investor to place his money with us instead of entrusting it to governments of undoubted standing.” (From speech of chairman of Rand Mines, Ltd., 1904.)

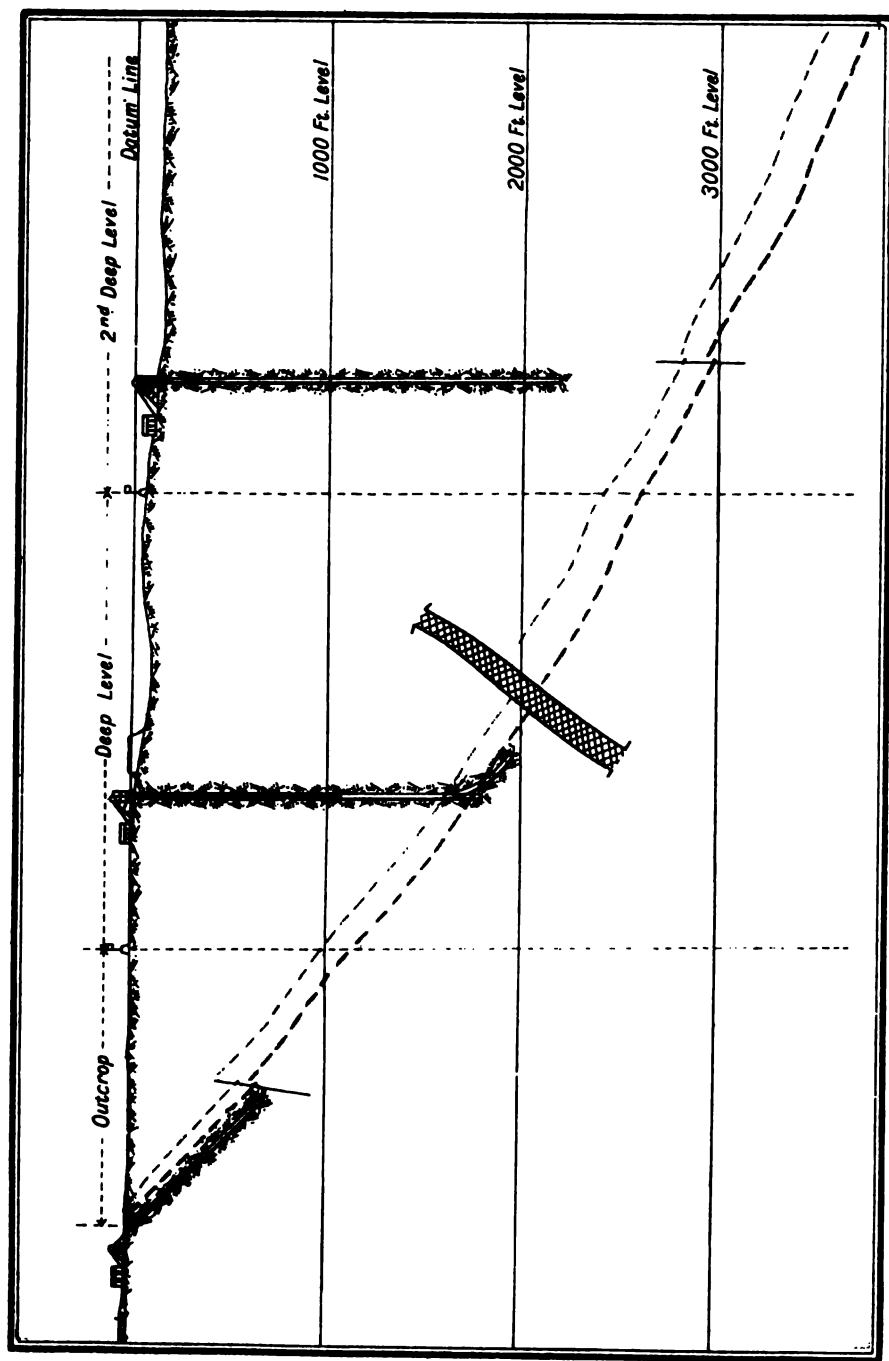
A few only of the Rand mines have turned out to be so good as the estimate of earlier years represented them to be. This is not the fault of the Rand, which is in all respects a phenomenal gold-field; the fault rested rather with those who made the estimates.

We now know that statements as to the almost invariable regularity of the ore, both in occurrence and in value, and from the surface to great depths—statements which have gained world-wide credence—were made on altogether insufficient data ; time has shown the fallacies on which they were based.

Most of these statements were made in good faith. Indeed, in the earlier days the evidence to support them seemed sure at almost every point. I know that some of my own estimates in the past about Rand mines have been too favourable, and I am glad to think that the empirical method of mine-valuation I imbibed while living in Johannesburg has been knocked out of me in other parts of the world.

It must also be remembered that an analytical account of the Rand mines from those who knew most about them was not to be expected. The unfavourable points, as they came to light year by year, were known to this or that mine-manager or consulting-engineer, and were no doubt conveyed to a partner of the financial house controlling the mine. But it was certainly not the business of the two former to shout these things on the house-top, and as for the latter, besides it not being to his own interest to make known the facts, doing so could not have helped the interests of the smaller shareholders, whose trustee he might reasonably consider himself. Few have the moral courage, where their own and other people's financial interests are concerned—especially interests of this magnitude—to proclaim unpleasant truths ; and I am not disposed to lay undue blame on any Rand capitalist or director for not doing what most other people would themselves not have done.

The rational estimate of the Rand—the estimate of 1905, not of 1895—is that it will last a generation and will produce probably not less than £1,000,000,000. As against this, it is now known to be of lower average grade than was first thought ; to carry patches of unpayable ore where not expected ; and to



A SECTION THROUGH THE MAIN REEF SERIES.

broken and faulted in many places. Evidence also goes to show that the average value is getting poorer with depth ; but whether this is a steady, gradual impoverishment, or only the fortuitous occurrence of a number of poor patches, cannot yet be determined. One thing is known for certain, which is that where the ore is not exposed the inferential valuation of any mine or area upon the evidence of adjoining mines, and the placing of a high capitalization on such property as the result, is unreliable and dangerous to the last degree.

The conclusion of the matter may be said to be that the individual mines are, on the average, not so good as was thought ; while the industry as a whole will probably be much greater than it was ever imagined to be.

As the great economic importance to the British of the Rand gold-mining industry becomes more apparent, the need for it being run on purely industrial lines will be seen. This industrial aspect will grow as time goes on. The present speculative glamour will wane. The gamblers will lose their money, and shares will come down to the levels justified by results. On that basis there is a great deal that can be done for the regeneration of the field, not in order to start another boom, but by way of giving fuller economic stability to a great industry. I propose to discuss some of the problems which bear on this.

The first matter is the position of the Transvaal Government in regard to the gold-mines. The relation between government and mines is of the closest. The soil of the Transvaal is poor ; little food is grown ; agriculture is unimportant, and there are no manufactures ; it may be said that, either directly or indirectly, the whole of the country's large revenue is derived from the mines. Part of this revenue is used to pay interest on a debt of £30,000,000. This debt will be increased to £60,000,000 should the informal promise to pay Britain a war-indemnity be carried into effect ; but it is to be hoped that Britain will decide to remit a large part

of this. In addition to this debt the municipality of Johannesburg and the Water Board between them will owe another £6,000,000 or £7,000,000.

One way and another the mines will have to pay interest and provide sinking fund on the whole of this debt, so that the close relation between the Government and the solitary tax-payer is easy to see.

The Government has mining assets of its own ; these are :—

- (a) 60 per cent in the Premier Diamond Mine.
- (b) Large areas on unproclaimed gold-farms in the East Rand.
- (c) Bewaarplaats claims, water-rights, and township sites on main reef areas.

If the whole of the profits under these three heads were set aside for the redemption of debt, a large part of the debt would be thus worked off. Cautious finance would indicate such a course, for in less than twenty years the cream of the Rand ore will be gone, and after that taxation may not show the elasticity it does at present. However, it is not the way with finance ministers to look far ahead, nor to accept the theories of an outsider on such a matter as this ; and I shall assume the Government will devote its revenue from its mining assets to current expenditure, and let the future, and the big debt, look after itself.

The tendency in the Transvaal, since the war, has been towards big expenditure in every direction—innumerable officials, high salaries, a Government loan, great municipal borrowing. As I have said, the whole of this is paid for, directly or indirectly, by the gold-mines, and the redemption of financial commitments to which the Government in name—but the mining industry in reality, has now been pledged, is a serious question.

The Government's most valuable mining asset,



ORE-CONVEYOR IN A RAND MINE STOPE

interest in the Premier Diamond Mine. It is possible that for a long time to come this interest may yield a profit of as much as £1,000,000 a year. It seems only right that this profit should be used exclusively for the redemption of debt. The Government's gold-bearing areas in the East Rand basin are assets of doubtful value, but of great possibilities. Whatever the value, it is clear that this ground should be exploited as soon as possible. With this end in view it would be a mistake for the Government to dispose of the ground, either by lottery or by sale. In either case, if so disposed of, it would not bring in a big sum in ready cash, and would eventually fall into the hands of the big financial houses. These people have already more ground than they can digest, and have got to provide about £30,000,000 to bring their already floated mines to the full producing stage. Under the circumstances they would not be able to start working these East Rand areas for many years. Why should not the Government determine to lease these areas on a royalty basis? Men of the big-contractor type could be found who would be willing to take on such a partnership, and by introducing new blood, new capital, and new methods of handling the ore, would do the country a lot of good.

The Bewaarplaats claims and water-rights are not such a valuable asset as they are thought to be. The rich claims are mostly in small blocks, and the bigger blocks are on the dip of the poorer mines. Furthermore, in equity, the companies in question have probably a very fair title to the mining rights of these claims, and in the forthcoming settlement I shall not expect the Government to exact from them anything like the full value of the ground. The mining rights under the townships of Vogelfontein and Boksburg, not yet disposed of, are probably more valuable than the Bewaarplaats, for these are large and well-located areas. A division of this ground between adjoining mines, the Government, as vendor, taking shares or cash, would seem to be the best way of disposing of these.

Although receiving the whole of its revenue from the mining industry, it is not expected that the Government should foster that industry to the exclusion of all others; indeed, those who control the mines are prepared to see a large portion of the country's surplus revenue diverted to other sources. The Government ought, however, in two matters to consider the interests of the mines as supreme. The first has already been referred to. That is the exclusive application of the Government's mining assets to the repayment of debt. The second matter is the insurance of an ample supply of cheap labour for the mines.

The Rand labour supply is an economic, not a political question. If, owing to scarcity of cheap labour, the Rand can only work at one-third or one-half its capacity, the financial effect on South Africa generally, and on thousands of investors in Europe, will be most serious. It has been shown conclusively that the local supply of cheap labour falls far short of requirements. There are several reasons for this. To begin with, the whole native population is not great, and of those available a large number do not care for the work of the mines. The reduced scale of pay after the war, since raised again nearly to the old figure, was also a retarding influence. Another reason is that the Kaffir is not now allowed to have strong drink. This he resents. He has been accustomed to it hitherto here, and in his Mozambique home can get as much as he likes to pay for. In the past his wages were spent on vile liquor, and having nothing saved up he was often content to remain on the mines for years at a time. To-day he cannot spend money on liquor, consequently he saves his wages, and is the sooner ready to return to his home, where, as a consequence, he is able to remain for a longer bout of idleness and drinking. The truth is, that the native will have liquor. If he gets none on the fields, he indulges inordinately at home. Why not, then, let him have it in moderation on the mines? The point is worth discussion. It is to the credit of the Rand companies that they supported the Government on the liquor law, for its introduction has been one of the main factors operating against a bigger flow of natives to work in the :

The permanent shortage of local unskilled labour has been removed by the importation of Chinese, those from the north, especially, being good workmen. These men come over under a three years' indenture, and will, no doubt, be found a satisfactory solution for the local labour shortage. It is more costly bringing over these men than recruiting labourers in South Africa, for the arrival of every Chinaman entails a cash outlay by the mine of probably not less than £20. As against this, he will stay for three years, and it is hoped that his greater efficiency during the last two years of his contract will at least make up for this extra initial outlay. Personally I am of opinion that many of these men will stay on after their term of indenture is finished, as the conditions under which they work—the food, the accommodation, and the pay—are much superior to anything in their own country.

If South Africa is to expand its agricultural industry, and to attempt to grow its own food supply, there is room for every native who will work to go back on the land. The farmers everywhere are calling out for labour; the scarcity of this of late years, and the higher price they have been called upon to pay in competition with the mines, has injured the whole position of agriculture in South Africa. This is another strong argument for bringing in Chinese to work the mines; for when sufficient have been brought in, the Kaffirs can gradually be drafted back to agricultural pursuits.

Why is it that white men—especially in a country such as the Transvaal, where the climate is healthy—cannot do work which the Chinese have been brought over to do? No doubt this question has been asked thousands of times, and as often answered, without reference to the facts. White miners could, of course, do the work admirably, and under normal conditions would be employed. But in the Transvaal two of the conditions are abnormal. In the first place you have got black men—natives of the country—already working in the mines, and because of caste the white will not work alongside of, or on an equality with, the black. This is an elementary

statement. People who have not lived in countries where black men are might be disposed to argue it, but no South African colonist, no one who has lived in India or the East, will doubt it. The white miner on this field, therefore, unless working a rock-drill, is not really a miner at all, but a superintendent of the work of the blacks ; in this capacity he is inclined to become flabby, and the tendency is towards inefficiency.

The other abnormal condition is the high rate of wage the white worker in these mines receives. The minimum wage of a skilled gold-miner here is more than the maximum in any other country. One reason for this is the high cost of living in the Transvaal, and another, no doubt, the fact that he is, or considers himself, a supervisor of labour rather than an actual miner.


On the Rand a wage of £1 a day is probably about the average pay of the skilled white miner. But a harder and better day's work is done by the miner in Victoria for 7s. 6d. or 8s. ; in Queensland, for from 8s. to 10s. ; in West Australia, for from 10s. to 15s. ; and in the States, for from 10s. to 16s.

With the idea of training miners from among the numerous unskilled whites who offer themselves for work, the mine-managers have made repeated efforts. The results are instructive. Most of these men—who, it is urged by people in England, should be preferred to Chinese—are loafers or drunkards ; others are physically unfitted for hard muscular work. Nearly all leave after a short time. Here are some actual figures. Between the end of the war and the middle of 1904 the manager of the Langlaagte Deep had had 1400 unskilled whites through his hands. They worked on contract, and the average sum earned per man per day was 9s. 11d. Despite this good wage for unskilled work, the men only remained on an average seventeen days. All refused to work alongside the blacks. Some were drunkards, others loafers, others were physically unfit. Of the few who remained the majority were Dutch. There is still a big field open on the Rand for unskilled men, a

are in earnest and who are fitted physically will be assisted to become skilled and highly paid miners.

Under present conditions an all-white labour supply for the mines is not feasible. The average Rand mine is essentially low grade, and if all its miners were whites, receiving £1 a day, or for the matter of that 16s. a day, it could not work at a profit, and would have to be shut down. As a matter of fact, there is a strong political reason *against* all-white labour. The life of the conglomerates is limited, and when they are worked out the mining industry of the Transvaal may not support one-tenth of those now dependent on it. There is yet no evidence that the country is rich in other respects; and to collect together a white community, which in course of time would number from 600,000 to 1,000,000 persons, utterly dependent on mining, in a poor agricultural country, is not a course that seems wise. Of course, the Transvaal, both in its mines and its other resources, may have a great future in store; that may become apparent in course of time. But if so, let matters adjust themselves without being forced. The tendency is always to employ more and more whites. When the newer mines are at work the white mining population will be a large one; but to force the mining population by Act of Parliament to be all white would in the end do much more harm than good.

When the Government has finally settled the Bewaarplaats question, a number of the mines will be able to bring about a long-contemplated rounding off of boundaries, and a mutual re-arrangement of interests. Some of these may be instanced. The Jumpers will hand over its deep claims to the Jumpers Deep on terms already arranged; the Crown Deep will part with its deeper ground to the South Rand, and development work will start on that important area; the Witwatersrand Company can hand over its awkwardly-shaped deep-level blocks to adjoining mines; and the Ferreira, Wemmer, Salisbury, Jubilee, Meyer and Charlton, Wolhuter, Goch, Henry Nourse, and various other companies, will be in a position to make more definite estimates as to how they stand.



I hope that these rearrangements of ground will lead to a series of big amalgamations all along the Rand, for it would be to the economic advantage of the field if the large number of small, short-lived mines, with their necessarily heavy managerial expenses, could be replaced by a smaller number of larger mines, with longer lives ; while the savings that could be effected in administration would be very big. This principle has already been acknowledged as regards newer flotations, where the ground has not yet been developed ; but I consider it economically applicable also to a number of the producing mines, and have specified such suggested consolidations in the previous chapter.

Another reason for amalgamation of smaller mines out of existence is the short life of most of them, and the bad effect which the shutting down of one after another of these dividend-paying properties will be likely to exercise on the industry. Dating as from January, 1906, the life of the Bonanza will end almost at once ; the Champ d'Or, Jubilee and Jumpers will end in two to three years ; the Salisbury in three years ; the Durban Roodepoort will have three years of its present rich ore left, and can then work eighteen months more on low-grade ore ; the Ginsberg has four years more, south of the dyke ; the Crown Reef should last four to five years ; the Rand Central and Wemmer five years ; Geldenhuis Estate should not exceed five years ; and the Meyer and Charlton probably less than six years. I, of course, do not say that these estimates are exact, but believe them to be not wide of the mark. If these mines choose to work bodies of low-grade ore, they can, no doubt, prolong their lives ; but as this ore would yield no real profit, the prolongation of life under such circumstances would not affect my figures. It is also open to the directors of such mines, when their richer ore is exhausted, to decide to work the main reef proper, which in many parts of the Rand, owing to its low value, has never yet been mined ; but I feel sure that this reef, even if worked in individual cases at no loss, will yield no real profit. The average recovery value from it of 12s. or 13s. is the maximum.

I should expect. On some mines it has been tested with this end in view. On the Bonanza, the main reef samples taken in 1903 averaged 13s. 6d. a ton, and the average of the whole mine was 12s. 6d. On the Durban Roodepoort the average of the main reef, excepting one richer patch which I have allowed for in the estimate of life, is 16s. 6d. These are gross values, and about a fifth would have to be deducted for loss in treatment. Another drawback to the value of the main reef would be the proximity of the old main reef leader stopes, which would seriously interfere with operations. Altogether I attach very small value to this supposed asset.

The coming to an end of these mines is a contingency which is vaguely realized as yet. It is a cloud on the horizon a little bigger than a man's hand. Shareholders in them take no heed of the position, and the approaching end is only in a few cases reflected in the price of the shares. Shareholders themselves, I feel sure, have taken no steps to redeem their capital out of dividends; and the directors, thinking, perhaps, that this is no part of their duty, have also made no provision for redemption. The natural result will be that nearly all the capital invested in these short-lived mines is going to be lost, and I am afraid that the reaction among the thousands of shareholders, when by the irrefutable evidence of the mines shutting down they at last discover their financial position, will do the Rand industry a great deal of harm.

Amortization, where a Rand mine is concerned, is imperative. It is of the essence of the thing. It is well known that the shareholders won't provide this for themselves, and I consider it should be done for them.

It may be argued that directors have no right to take on themselves such arbitrary powers; that the shareholders have bought their shares in expectation of a certain dividend, and that they have the fullest right to dispose of their dividends in any way they please,

regardless of the obligation of redeeming their capital. On the other hand, I would point out that directors are paid to look after the best interests of the shareholders; that Rand directors are mostly specialists, and sounder judges of the financial bearings of this question than the average shareholder can ever be; and that to them the actual knowledge of the coming exhaustion of the mines is brought home in a way which it cannot be to the layman in Britain or France or Germany.

My view is that there can be no doubt on this point. The Rand is unlike other gold-fields in that each claim, or each block of claims, only contains a definite quantity of ore, and when that is gone the area is valueless. Those interested in this gold-field are continually engaged in telling the world of its uniqueness, its certainty, its even tenour as regards contents of ore and of gold; and they argue from this that Rand mines should, therefore, be looked on as far superior in security to other mines. To a great extent they are right; but with this greater all-round regularity and security to rely on, surely the financial problems appertaining to such mines should be worked out on the soundest lines. And what can be sounder than to insist that the redemption of the capital involved in exploiting one of these areas—with its definite number of claims, its maximum tonnage of ore, and the certainty of its exhaustion at no distant date—should be regarded as essential and not even open to argument?

How, it will be asked, is a board of directors to undertake this redemption of shareholders' capital? And is it not, financially, a very delicate and dangerous task? The first step would be to arrive at an approximate estimate of the amount of payable ore still remaining in the mine. I call this estimate approximate, because it is not possible to work it out to within a month, or perhaps a year; but a fairly accurate estimate, at least of all the smaller mines, is quite possible. As a rule the directors of Rand mines, question of the life of the mine have not been explicit. Th

often tried to lull any anxiety which may have shown itself by arguments not entirely sound—such as the fact of the ground already exhausted having produced more ore than was expected, or the possibility of the main reef being worked at a profit. In their yearly reports, too, they have often failed to show clearly the proportion of unpayable ore developed, but left out of the reserves, and have allowed it to be inferred that all the ore in the reefs under exploitation was profitable. I think a clearing up of many of these points—especially where the smaller and short-lived mines are concerned—is due, as from the directors to the shareholders.

Once the definite, payable tonnage left in the mines had been arrived at—or approximately so—shareholders should be called together and asked if they wished to initiate a policy of redemption of capital. If they did not so wish, the responsibility would rest with themselves; but I venture to think that they would decide otherwise.

One way of meeting the redemption question is that already referred to—the absorption of all the smaller mines by the larger adjoining mines. These bigger concerns, not troubled by the immediate fear of early exhaustion, as are so many of the smaller mines at present, could elaborate and carry through a definite scheme of redemption of capital; the long life ahead for them being the principal factor determining such a scheme.

Another way of effecting redemption of capital—assuming that neither directors nor shareholders will agree to their mine being absorbed—would be the present cessation of dividends, and the building up of a strong cash reserve fund. This would not serve the purpose of the ordinary reserve fund, but would be specially devoted, whenever opportunity offered, either to participating in some new flotation of deep-level ground, or east or west extensions of the Rand, or to the purchase of shares in such a venture. At this point a question in ethics presents itself. Nearly all the mines on the Rand, including the short-lived, are controlled by one or

other of the big houses, and these houses receive a large sum in directors' fees to look after the interests of the mines in question. Let us suppose that one of these houses intends to purchase and float off a large tract of new ground which promises to be valuable, and wants to do this entirely with its own capital. And suppose, also, that the same house controls several small mines with short lives, and that the shareholders of these mines pay the house large sums in directors' fees to initiate the best policy for these mines. How are these conflicting interests to be reconciled? It seems to me that the controlling house owes a duty to these mines, and that that duty can only be settled by the offer to each of a reasonable share in the underwriting of the capital needed for the purchase and equipment of the supposedly valuable ground in question. But previous to that, the big house controlling these mines should, through its nominee directors, have prepared the mines for such an opportunity by building up a substantial reserve or "redemption" fund, and that, again, could only have been done after the shareholders had been properly educated up to the question of the mines' short lives, and the urgent need of such a fund.

Besides these questions of redemption of capital, short lives, and consolidations into large concerns, the controlling houses of the Rand have got to consider some financial problems of a personal nature.

On the Central Rand alone, to bring to a full state of production the properties already floated by them, these houses have to make provision for raising a further £29,000,000 for working capital. It is evident that this can only be raised with the assistance of the public; provided, however, good terms are offered, there is no reason why the public should not so participate. But what are good terms? Now that the Rand, where its individual mines are concerned, has so often failed to come up to expectations, the terms which used to be considered as good ought now to fail to attract. The day for empirical capitalization is gone; and to ask the public to buy into unproved areas, on a capital basis of several millions, merely because a mine a mile distant is working at a profit,



KAFFIRS WORKING IN A RAND STOPE

with our present knowledge, be considered justifiable. Let the gambler reflect for a moment. If there comes a new Rand flotation, and he rushes to buy the £1 shares at a premium of, say, £4, what does this imply? The Rand Victoria, to take a definite example, was floated in 1895, and people gladly bought the £1 shares at £4. It is now 1905, and one shaft has just been started. This mine will not start production till seventeen years after it was floated. In the meantime, seventeen years' interest, added to the purchase price of the shares, will have more than doubled the original price! This factor—the loss of interest on Rand shares between the time of flotation and the commencement of dividends—would show really appalling figures if analyzed. The inference is, of course, that the promoters have in the past received far too much for their shares, and the “terms” they are prepared to ask the public to accept for the future should take this factor of loss of interest into full consideration.

Two more financial questions must be noticed.

The first is this: before the war some of the controlling houses got into the way of guaranteeing blocks of shares at certain prices in many of the new flotations. These shares, for one reason or another, were not subscribed for or taken off the promoters' hands by the public, and the houses were left with them. The guarantors then argued thus: “These mines are not going to start work yet. They have no need for all this money, which we did not stipulate was to be paid up immediately. Our guarantee is perfectly sound, and we will just pay up the money from time to time as required.” To a certain extent this argument was a fair one; but let me put the argument from the other side. Even if the mines were not working, these large sums of working capital could have been put out at a good rate of interest, and have earned at least enough to pay current expenses. Independent boards of directors would have made a strong effort to get these sums—which aggregate about £4,000,000—paid up; but as the boards of the companies consisted of nominees of the guarantors themselves, this was not attempted.

This sum of £4,000,000 is a big one, but only relatively so when we consider the financial strength of the firms involved in these guarantees. It would, no doubt, inconvenience—shall I say seriously inconvenience?—these firms to pay up all this money right away; but I do not for a moment doubt that their resources are equal to such a demand on them. I do not believe in abusing the Rand capitalists, as some people do, and assuming they can do no right. As a matter of fact, they do many things they never receive due credit for. Even in this question I have no doubt that their contracts stipulate that the guaranteed sums are only to be paid up when required. But then, who is to say when they are required? Certainly not their nominee boards. I say, as an observer of things on the Rand, that these sums are required, and at once.

There is another matter, while on the subject of big houses and their finance, which I cannot condone at all. Some of the mines which had large paid-up working capitals, have lent this money back to the controlling-house. The trouble here, again, has been that the big house appointed its nominees to the board of the company, and these nominees were forced into doing this action. I believe that the list of mines so involved is a short one; but if I were a shareholder in one of these mines, I would not rest till the matter was put right.

Does the Rand become poorer with depth? And what is to be the history of the deeper mines? These are questions I have often pondered over, arriving on the whole at unfavourable conclusions. The deep-level areas below 2000 feet vertical have been a disappointment. So far they have given poorer results than the shallower ground immediately above them, and in certain cases show ore that is not even payable.

We really know very little about the deeper ground of the Rand, but are beginning to realize that the occurrence of the ore—apart from the question of impoverishment—is bound up

number of unfavourable factors. Some of these may here be specified. There is a great deal of faulting. Take the well-known case of the stretch covered by Knight Central, Simmer East and South Rose Deep. In these mines the reef has been thrown up 1000 feet. But where does this fault occur? for it cannot be expected to synchronize with the respective boundaries of the mines. The fault lies either within their areas, or in those of the mines above them, and will in time to come entail a readjustment of boundaries. That is one fault out of many.

Dykes, too, will cause much trouble. Such mines as Robinson, Robinson Central Deep, South Rand, and Glen Deep, lose an appreciable area of their property by these. There is a stratified dyke running parallel with the main reef leader in the lower levels of City and Suburban, Meyer & Charlton, Wolhuter, and Goch, which often cuts that ore-body out altogether, and may do a great deal of unforeseen damage. There is an immense dyke, 2000 feet wide, showing on the surface of all the mines from Witwatersrand Deep to South Nourse. This dyke dips, presumably, at a steeper angle than the reef formation, and at a vertical depth of somewhere between 4500 and 6500 feet (that is to say, usually in the row of mines below the row in which it outcrops) should come in contact with the reefs. It may be that this dyke is really parallel with the formation, in which case it would do no damage. But there is yet nothing to tell us this; and for all we know it may cut through the reefs and cause serious dislocations and loss of ore. Fortunately this refers to ground beyond the 4500 vertical line, and this is ground which I do not take seriously into calculation; but what a risk to buy into these very deep and unknown properties! Another serious factor is the continued discovery of poor patches of ore where not expected. Take note, under this head, of the history of such mines as the Glencairn, Wolhuter, New Heriot, Jumpers, Rose Deep, Knight Central, South Rose Deep, and Simmer East.

Another curious case of local impoverishment may be noted. In the lower levels of the Wemmer and the Village Main Reef, extend-

ing down also to the Village Deep, the once rich South Reef loses value. This is only in part balanced by a better than average value in the main reef leader over the same area.

Although evidence goes to show a definite falling off in average value with depth, we may look on this point as not yet proved. The Robinson Deep, working below 2000 feet, although of lower grade than the mines above it, is turning out a fine mine, and at 4000 feet the ore in the Jupiter has been shown of good value. These are the favourable exceptions among the deeper mines; but they show that at least in places the Rand will be payable to great depths.

Whatever the future of the moderately deep ground lying between 2000 and 4500 feet vertical, all the reef deeper than this, both for financial and physical reasons, should be altogether written off by practical people.

This deeper ground, with perhaps the exception of the Turf Mines, is not likely to be worked by vertical shafts. It will, as a consequence, be dominated by the 3500 or 4500 feet row of shafts, and the companies owning these will hold a perpetual lien upon all the deeper ground.

Bound up with the prospects of the deep levels and the newer mines in general, is the problem of greater economic efficiency.

A low-grade mine, such as the average Rand mine is known to be, can only hope to repay the large capital sunk in its equipment, plus interest on that capital, by the magnitude of its operations; and these, again, depend on the existence of a great quantity of ore. In this respect the Rand has nothing to fear; between the surface and 4500 feet vertical, the amount of ore which this field will produce—ore which will, at least, pay for the cost of treatment—will be immense. But that ore, to render the maximum of profit, must be intelligently parcelled out between the different mines. In the new era of management now shaping, the technical advisers are going to make the quantity of ore in a mine the big factor; it ought to be, and we shall see the gold-field parcelled out into

and bigger mining areas. The engineers now know that the Rand is essentially a low-grade field. They know that poor patches of big extent are liable to be met with anywhere, greatly reducing the assumed profit from any given area. The actual cash outlay on the deeper mines has been brought home to the big houses. They see that the strain of doing things in the old way is too great; that instead of shafts 500 yards apart they must be a mile apart, and that the areas these shafts tap must be similarly extended. They realize that two shafts will be cheaper to sink and equip than six, and that one mill of four or six hundred stamps will be cheaper to erect and run than four small mills.

A lesson in such centralization and in reciprocity between adjoining mines is shown by the New Kleinfontein Company. On this mine is installed a central administration for about eight of the neighbouring mines. One central store is used, connected up by a branch line with the railway. One coal contract is made with an adjacent colliery, and the several mines are connected by sidings. One foundry and repairing shops stand in a central position; and such things as purchases on joint account, accounts, and the various details of administration, pass through the one centre. When other mines of the group are ready to crush it is possible that the Kleinfontein mill, now of two hundred stamps, may be increased to four or six hundred, and all the ore run to this large central unit. The scheme is one which should be widely applied all along the Rand.

Other matters which demand attention are: Better underground work as far as the white miners are concerned, and closer sorting of the ore on the surface. I venture to think that each of these can be improved upon. On these bigger mines everything will be on a bigger scale. Already levels are being driven 200, 250, and 300 feet apart on some of the mines, as against 100 feet in the past. The levels still follow the course of the ore, and the trucks are shoved by Kaffirs. In the new era I shall expect levels 300 feet apart to be laid out dead straight, independent of the reef, and

to be equipped either with endless rope haulage or with travelling belts, which will convey the ore from stopes to bins with the minimum of handling.

Most of the mines have now introduced automatic methods for emptying the stopes which, besides saving several pence per ton in handling, will give the key to the introduction of somewhat similar methods along the levels.

In experimenting with a stope conveyor on the Rose Deep, figures were arrived at showing the saving effected by its use. In a stope of 22° the conveyor, or shaking trough, moved five times as much rock, in the same time and over the same distance, as did shovelling; while the figures in a 26° stope showed four times as much.

When we come to discuss the surface equipments we find the same ideas still at work, i.e. that with low-grade ore and big capital expenditure it is essential to work at the fullest pressure. Every mine on the Rand with any area of reasonable magnitude is to-day planning to increase its plant. Those in technical control have fixed on the tube-mill as the most efficient agent in this respect, and, by its introduction as a subsidiary to the present stamp-mills, hope to increase greatly their crushing capacity at a reasonable cost.

Without entering into technical discussion of the value or otherwise of tube-mills on Rand ore, I may point out that the proposal to introduce these, and to greatly augment the present crushing plants, is indicative of the trend of thought. It is seen that a new economic era must dawn for the field; that the new mines must be run on a bigger scale, and that a bigger tonnage and greater all-round efficiency must be the policy for all of the older mines which have big areas of ground. In this new scheme of things there is no place for most of the outcrop mines, with their small areas of ground. It is an eyesore to see these small mines, a that in a few years most of them will be worked out and

VIII Level $\frac{1}{2}$ of Tq. S: Reef $N^{\circ} II^{\circ} E$. Slope. East Face.

Date 6/8/08.

[illegible]



It is also an eyesore to see all their shafts crowding one upon another, and all their costly equipments, and to think of the cost to the industry of a dozen boards of directors and a dozen staffs where one would be sufficient.

In his report for the year 1903, the Government engineer says he had occasion to inquire into the lives of thirty-six of the Rand mines.¹

He found that the ore remaining in these mines, as at 30 June, 1903, was about 109,000,000 tons; that the estimated profit to be won from this ore was £102,600,000; and that the average life of the mines from that date would be 14·9 years.

It is reasonable to believe these figures to be approximately correct. They were prepared in connexion with the Government's tax on profits—to show what amount of the so-called profits was assessable for tax, and what amount was really return of capital—and were no doubt agreed on by the mines' department after discussion with the different managers and boards of directors.

When, eighteen months later than this, I wished to figure out the value of the Rand as a whole, I took these figures as one of the bases, and arrived at the following statement :—

	£	£
Profit remaining in these		
thirty-six mines at 30 June,		
1903	102,600,000	
Less dividends since paid, say	3,600,000	99,000,000
Current Market valuation of		
these mines		71,300,000
Average life of mines from January, 1905, say,		13·5 years.

¹ Angelo, Bonanza, City, Crown, Crown Deep, Durban Roodepoort, Durban Deep, Driefontein, Ferreira, Ferreira Deep, French Rand, Geldenhuis, Geldenhuis Deep, Henry Nourse, Nourse Deep, Ginsberg, Glencairn, Glen Deep, Jubilee, Jumpers Deep, Langlaagte, Langlaagte Deep, Lancaster West, May, Meyer & Charlton, New Comet, New Goch, New Heriot, New Primrose, Rose Deep, Robinson, Roodepoort United, Simmer & Jack, Village Main Reef, Wemmer, Worcester—amongst the richest of the Rand mines.

From these figures the following conclusions are drawn: A sum of £99,000,000 will be earned in 13·5 years. This is equal to £7,388,000 a year, or to 10·3 per cent interest on the current market value of the mines in question. At the end of this period the mines will be worked out, and will be valueless, so it is imperative to set aside a large part of the interest to redeem the loss of the £71,300,000 capital involved.

The yearly amount (payable in half-yearly instalments), which must thus be set aside is £4,176,868. This fund, accumulating at 3·5 per cent interest, will amount in 13·5 years to the required sum of £71,300,000.

The balance of the yearly profit represents actual interest on the investment.

These figures may be summarized in this way:—

			Yield on current market value.
Yearly profits from thirty-six mines	£7,388,000	...	10·3 %
Yearly sum which must be placed to redemption	£4,176,000	...	5·8 %
Balance—being actual interest on investment	£3,212,000	...	4·5 %

These figures, of course, represent the average of thirty-six mines. In individual cases, depending on the life of the mine in question, the proportion of dividend necessary to be set aside for redemption of capital might be more, or might be less, than the average figure here given. If shareholders in these mines do not make this necessary provision, they will in due course consume the whole of their capital.

Now let us consider the value of the Rand as a whole from another point of view. This time the figures are my own. The mines concerned are all those situated on the Rand proper whose market values are those of 7 February, 1905.

Here is the statement :—

Publicly owned mines on the Main Reef between Boksburg and Randfontein .	130		
Market valuation of these at 7 February, 1905. (Due allowance has been made for the various assets owned by some of these mines.)		£ 147,200,000	
Further capital expenditure required to bring them up to full efficiency		29,070,000	
		<u>£ 176,270,000</u>	
Eventual number of stamps which— assuming simultaneous production— could be worked on these mines .	18,075		
Number of tons crushed per annum by 18,075 stamps	30,727,500		
Estimated average dividend per ton .	9s.		Interest on market price.
Estimated total annual dividend	£ 13,827,000		7·8 %
Yearly sum which should be placed to redemption of capital	£ 7,112,000		4·0 %
(This yearly sum accumulating at 3·5 per cent interest would redeem the capital at stake in eighteen years. The average life of the mines might be more than this, or might not, but even on a basis of eighteen years the investor is making a very great allow- ance for the reefs' permanence of value.)			
Balance—being actual interest on in- vestment	£ 6,715,000		3·8 %

The number of mines in question in this calculation, their market price at the date given, the further capital expenditure required,

the number of stamps which might be worked, and the tonnage which these would crush, are factors about which there can be little dispute. The really important factor in the estimate is that dealing with the dividend per ton which will be earned, and I had better explain at length my reasons for arriving at the figure of 9s.

The first evidence to be studied is a statement of the results already obtained.

TABLE SHOWING RESULTS FROM THE RAND—PER TON CRUSHED

Year.	Number of tons crushed.	Value.	Dividends paid.	Value per ton.	* Costs per ton.	Dividends per ton.
		£	£	s. d.	s. d.	s. d.
1893	2,203,704	5,187,206	1,100,203	47 0	37 1	9 11
1894	2,827,365	6,963,100	1,502,994	49 3	38 8	10 7
1895	3,456,575	7,840,779	2,161,493	45 4	32 10	12 6
1896	4,011,697	7,864,341	1,545,256	39 2	31 6	7 8
1897	5,325,355	10,583,616	2,722,055	39 9	29 7	10 2
1898	7,331,446	15,141,376	4,847,505	41 4	28 3	13 1
War period						
1903	6,105,016	12,146,307	3,345,499	39 8	28 9	10 11
1904	8,058,295	15,539,219	3,855,312	38 5	28 11	9 6
	39,319,453	81,265,944	21,080,317	41 4	30 8	10 8

* By "Costs" is meant everything not paid away as dividend.

This table shows the result of eight representative years' work on the Rand—in its relation to the ton of ore treated. The figures show a gradual falling-off in the average yield, which, however, is almost balanced by a gradual decrease in the working costs; and the important factor—the dividend per ton—remains much as it used to be.

This factor of the "dividend per ton," for the period in question, might be shown in a more favourable light if we took account of (a) Excess development (b) Additions to plant. Both of these items in a number of cases have been paid for out of profits, and it is possible that the actual profit available for dividend has not been short of 12s. per ton crushed.

If, then, the actual dividend per ton over all these years has averaged 10s. 8d., and might have been made to average nearly 12s. ; and if for the future my estimate allows for no more than 9s., it is clear that I must set down my reasons for arriving at such an estimate. The main reason, of course, is that the ore treated on the Rand up to the present has mostly been drawn from the richer areas. This is not a controversial matter, for there are a number of mines on the Rand closed down because of the low value of the ore, and it is only, moreover, on the richer sections that any deep levels are as yet producing. This reason, applicable to the field as a whole, is also illustrated in the history of the mines individually. First they commenced with a small mill, and the richest ore was treated, and as the mill increased the proportion of poorer ore was raised. Many of the mines have not yet lowered their grade to the figure it ought to stand at, but are gradually doing so. I don't think that this point either is controversial, for a study of the yields of individual mines for, say, the years 1894-5 and 1904-5 does not leave much room for argument. I do not infer that the mines are necessarily getting poorer, but rather that they are now treating a fairer average of their ore than used to be the case. The point at issue is as to whether the average grade of the ore crushed is falling off, and on that point I think the evidence is conclusive.

There are several factors which may raise the grade of the ore, or rather, which will help to prevent it falling too much, both in the rich and the poor mines. The first is close sorting. This, in turn, depends upon an ample labour supply, and on the use of hand-drills in narrow stopes. The amount of waste rock sorted out in 1898 was 20 per cent, and in 1904 18 per cent. It would be possible, no doubt, to raise the average to 25 per cent ; and this may be done. The second factor is that of a better extraction of the gold, due to improved metallurgy. Under this head is to be noted the recent successful treatment of 2 to 3 dwt. slimes at a reasonable cost, and the favourable experiments in fine grinding. I do not underrate the increase in grade to be derived from these sources, nor the increase

which would come from closer sorting, but I am of opinion that these will be much more than balanced by the factors which are making for an all-round decrease in grade.

In the past several reasons prevented the more active exploitation of the poorer sections of the Rand. But I take it these no longer exist, and that there is nothing now to prevent the working at full capacity of all the lower-grade mines. The increase in the output from the lower-grade mines, furthermore, promises to be relatively larger than that from the richer mines, some of which at least have problems of their own to settle with regard to grade.

My belief is that the future average yield of the Rand, working on the very big scale foreshadowed in my estimate, will not be more than 33s. per ton. It will be noted that this is 8s. 4d. a ton less than the average of the eight years' work shown above, and is 5s. 5d. a ton less than the average for 1904.

As against this I assume that everything recovered over 24s. a ton will be available for dividend, that is to say, an average dividend of 9s. a ton. This estimate allows for a decrease in costs from the eight-years period of 5s. 8d. a ton, and from the 1904 figures of 3s. 11d., which appears to me not an illiberal figure.

I have allowed nothing in this estimate for the ore of the Rand—as a whole—becoming poorer with depth. A gradual falling-off in grade has certainly been allowed for, but that will come about from causes unconnected with any definite falling off due to depth. I think that from a technical point of view I would have been justified in allowing for at least a moderate decrease of value with depth. As I have not done so in this estimate, my critics will perhaps reckon it unto me for righteousness.

Of course, it will be years before one can strike even an approximate average of future yield and expenses, and factors as yet unthought of may arise to alter our ideas. The figures here be it remembered, relate not to individual mines, but to

as a whole, and one must not apply them indiscriminately to specific cases.

Whether right or wrong, however, this estimate of yield and of costs has more an academic than a practical interest. The grade might average 34s. or 35s. a ton, and the cost, instead of being 24s., might be 25s. or 26s. The important figure is the future "dividend" per ton, and I believe that in placing this at not more than 9s., I am very near the mark.

There is another side of the question to be considered. Contingent upon an average dividend of 9s. a ton, an average return of 3·8 per cent on Rand shares is shown. This, however, depends upon the working of over 18,000 stamps, and the working of these, in turn, depends upon the initial expenditure of £29,000,000 in hard cash. Great as it is, this sum might under present conditions figure out at several millions more, but I have assumed and allowed for a series of consolidations, especially among the deeper mines, with the consequent saving in equipment which would be brought about.

The raising of £29,000,000 is not child's play. Without it the mines could not produce at the estimated capacity, and the interest I have allowed for could not be earned. But I assume that this money will be found, for the Rand industry is too important to languish for want of working capital. The money will not all be provided at once, nor is it all required at once, for the development of mines, especially of deep mines, is a slow process.

As a matter of fact, although my estimate assumes all the mines on the Rand to be producing simultaneously, physical difficulties will not allow them to do so. It will be five, eight, or even ten years before some of the deep mines commence to produce, and before that time a number of the older mines will have come to an end. There will never be, in all probability, 18,000 stamps working simultaneously between Boksburg and Randfontein, and the hypothetical yearly tonnage of my estimate will not be realized in practice.

The estimate of the interest to be earned on Rand mines presupposes all the mines to start work at once. This of course they cannot do, and it is easy to see that the loss of interest on the capital invested—from now until the time when all the mines are paying dividends—should be taken into account. What this loss precisely will amount to, one cannot venture to say, but it will be a big loss. I show elsewhere how serious a factor in Rand economics this deferred earning power of much of the capital invested really is.

It is fair to take note of factors which might improve the average earning power of the industry. Two such occur to me. These are :—

- (a) More rapid exhaustion of the mines than is now contemplated, with a consequent return of capital invested over a shorter period.
- (b) A series of consolidations into larger units, with a consequent saving in working and administrative costs. These are possibilities certainly, and are not included in the future saving of 3s. 11d. a ton allowed for; but their benefit is not as yet actual, and cannot be held to balance that factor of loss of interest just referred to, which is actual, and against which nothing has been written off.

The net results of this inquiry may be stated as follows :—

- (1) Based on the Government figures, 36 of the Rand mines will return the investor his capital, and interest at the rate of 4·5 per cent.
- (2) Based on my figures, the 130 mines of the Rand will return the investor his capital, and interest at the rate of 3·8 per cent.

It must be admitted that though these results are not desperately bad, they are not a good return on mining shares, where there are elements of risk.

It would be possible to produce a set of figures show

favourable result than those we have been considering if one were allowed to reject from the calculation half of the mines on the Rand. The mines to be omitted from such a calculation would fall under three heads :—

- (a) Very low grade or badly broken mines which have never yet earned a profit.
- (b) Most of the short-lived outcrops.
- (c) Mines requiring shafts deeper than 4000 feet.

If these three types of mine were eliminated, the Rand, from an interest-earning point of view, would be in a relatively sound position. Under present conditions, taking the good with the bad, and the prices as at February, 1905, the over-valuation of the field is undoubted.

CHAPTER VII

THE GOLD-MINES OF THE TRANSVAAL—(*continued*)

THE EAST RAND BASIN AND OUTSIDE FIELDS

THE map at the beginning of this book shows the East Rand basin. This gold-field is the natural continuation of the Witwatersrand conglomerates eastwards from Boksburg. For reasons which seem sound I have decided to treat it as separate from the Central Rand.

Three years ago the geology of this section of the Witwatersrand was in embryo. It was assumed that somewhere the rim of the conglomerate turned round from its easterly course, and joined up with the reefs of the Heidelberg district; but as the outcrop in this region was covered with later rocks, no precise data were then available.

Since the war, however, a great deal of boring has taken place on this area. Reference to the map at the beginning of this book will show 121 boreholes sunk in or just outside the basin, and there have been others outside it which are not all shown. The net result has been to define with considerable precision the area underlaid by the reef, and to connect up the Rand with the section of reef worked by the Nigel mines. From two miles beyond the Nigel to the town lands of Heidelberg, a distance of six miles, the continuation of the reef series has not yet been traced. In this locality it is probably poor, and it has been no one's business to sink money in boreholes. Two or three, however, showing presumably good value, have now been put



AERIAL TRAM IN RAND STOPE

town lands, which should attract interest to this locality, and it is no doubt only a matter of time for the reef lying between the towns of Boksburg and Heidelberg, and forming the "East Rand basin," to be indisputably linked up.

The discovery of this large new gold-field has come ten years too soon. Much of the working capital, destined in the ordinary course of things for the Central Rand, is being diverted here. This is to be regretted. As I have shown, the Rand still needs about £30,000,000 in hard cash, and the diversion of so much money to the East Rand will surely affect the supply; for I assume that the capital actually available for any given time for developing mines is limited, and what is diverted to one source is lost to another. The Central Rand is without question the more important gold-field. With all its vagaries it possesses the essentials for a great industry, and money laid out there in actual exploratory work, and in plant and machinery—as opposed to money put into shares at big premiums—will as a rule justify the outlay.

Compared with the Central Rand, the East Rand basin is relatively unproved, and the working capital that is being diverted from one to the other may, much of it, be sunk with no return.

The strength of the East Rand's attraction lies in two facts. Firstly, the properties are mostly of large area as compared to the small size of Rand mines.

Secondly, the whole of the East Rand basin carries the reef at a relatively shallow depth. Probably in no part does the reef lie at more than 5000 feet, and the 4000-foot contour embraces by far the greatest part of the basin. Speaking generally, there is a very large area of the field in which the reef lies at less than 3000 feet. As a number of Central Rand companies have been floated since the war in which the reef lies at from 4000 to 8000 feet deep, the discovery of all this relatively shallow ground cannot fail to attract notice. The people who put their capital into the new field take note of its shallowness, as compared with the "deeper deeps," and no doubt fail to look closely into its other characteristics.

A comparison of the East Rand basin with the Central Rand is interesting. It is probably greater in superficial area, because over the whole of it the reef lies at a workable depth. In ore contents it cannot compare with the Rand proper. That field shows one reef in places, but more generally two, or in certain areas three reefs; these are mostly of a good width. As against these, there is only one reef over most of the East Rand, and that is usually quite narrow. As to regularity of gold contents, it is doubtful if the East Rand will ever compare with the Central section. This, of course, is the crux of the question, and cannot be known exactly for a long time to come. On the evidence to date, I am inclined to think that there is no comparison between the two fields in this matter. Nearly the whole of the Rand, at least in the outcrop mines, should some day or other be worked profitably. No doubt, along considerable stretches the profits will be small; but still, one way and another, the ore will pay to take out. On the other hand, I doubt whether long stretches of the outcrop mines of the East Rand will ever be worked at all. I doubt whether the ore in these stretches even comes near the margin of profit. Take note, under this head, of the several miles of outcrop in Apex; of the longer section through Modderfontein Extension, Klipfontein, and Holfontein; and of the long impoverished stretch through Vlakfontein and Marievale, right up to the boundary of the Nigel.

If the outcrop area is poor, too, the same characteristics are more than likely to persist in the deeper ground. Of this, as yet, there is not much evidence one way or the other, as no actual exploratory work has been done. If we go by boreholes, we must come to the conclusion that very much of the deeper ground is poor. Out of 121 boreholes there are only 14 which show a gross value of 30s. a ton over a stoping width, and most of these are located in one section. It is, of course, not correct to assign too much importance to the evidence of boreholes, especially over such a great area, but they cannot help being influenced by them to a certain extent.

The method of working, over most of this field, will be different from the Rand method. The reef is usually narrow, lies on a slate footwall, and at a very flat angle. A narrow reef can be to a certain extent balanced by the company owning a bigger area of ground; but the narrowness, combined with the fact that there is only one reef, will add materially to the cost of development. The slate, as against the sandstone footwall, is an advantage, for the ore can be broken more easily and cleanly. The flat angle is, and is not, a drawback. Where the dip is steep, as on most Rand mines, the shovelling of ore from the stopes is much assisted; where the angle is between eight and fifteen degrees only, as it is on a large area of the East Rand, ore can be stoped on the "long wall," and automatic conveyors of some sort carry it from the stope face to the shaft.

The small tonnage per claim—the natural result of a narrow reef and a flat dip—seems to be the outstanding feature of most of the East Rand basin, and high working costs for this field are indicated unless mining is carried out on a big scale. Because of the small tonnage per claim, an area of 400 claims to the 100 stamps will as a rule be required; but it seems to me that, in view of many poor patches, far larger areas than this should, to begin with, be provided for.

The valuation of the East Rand with the Central Rand, claim for claim, is still much in favour of the newer field. That is an argument I have had to consider; but I find it is not a sound one. The unproved state of the newer field, as compared with the Rand, and the very much smaller tonnage of ore it carries—often less than 10,000 tons a claim—show this method of comparison to be very crude.

It is to be noted that the Transvaal Government has a big interest in this gold-field, much of which has never been proclaimed as public diggings. After the companies have laid off the areas they are entitled to, in the shape of mynpachts, werfs, etc., the

remainder of the farms belong to the Government, which will thus become the owner of probably over 20,000 claims. Much of this ground will, no doubt, be poor; but a good deal of it should eventually prove of value. It is to be hoped that the Government will entertain offers for the working of this ground on a system of profit-sharing, or royalty. On such terms fresh capital might easily be attracted to the field, and an influx of new blood and new methods would do good all round. It seems better that this asset should be made use of at an early date, rather than treasured up for years to come. If the gold can be got out at a profit, or made to earn interest, it is better than that it should be left in the ground.

It must not be inferred that, though this field compares unfavourably with the Central Rand, it is likely to turn out a failure. Large sections of it are certainly of no commercial value. But, on the other hand, it is of great extent, and if only a tenth of its area paid to work, it would be reckoned an important gold-field. We know that certain parts of it are good, such as the Kleinfontein—Van Ryn section—for these are profit-earning mines, with big ore-reserves. We believe, too, that other large areas, where good borehole results are shown, have reasonable chances of success. There is every reason why prospecting and exploration should take place all over this field for years to come; and though this may result in diverting capital from the Central Rand, once the field had been discovered such a state of affairs was inevitable.

At present the most attractive areas in the East Rand may be thus roughly outlined:—

(1) The outcrop section, New Kleinfontein—Van Ryn, with probable continuation of payable ore down into Van Ryn Deep and the western part of New Modderfontein. This area may spread out and embrace on the one side all the Modderfontein area, and on the other side the lower parts of Benoni and Chimes West; also Kleinfontein Deep; but one cannot be certain of this yet. On the farther dip of this same area one borehole on Apex and several on " " have shown promising results, and it is possible that the

payable ore outcropping in New Kleinfontein and Van Ryn may be found to penetrate, in a more or less clearly defined way, to a considerable depth.

(2) The second area of promise is that tapped by two good boreholes on Rand Collieries, and by two more on that part of the Van Dyk Proprietary immediately adjoining. One would expect from four good holes in a bunch like this that there is a considerable area of payable ore.

(3) Some of the Geduld ground, with, perhaps, a part of the Cloverfield ground adjacent. This same run of ore may continue to the farm Rietfontein, on which the Eastern Exploration Company sank two encouraging boreholes.

I will now deal in detail with the companies on the East Rand field, taking, firstly, the outcrop mines.

The **Apex** Company owns the large farm Rietfontein, but on the shallower portion of this, at least, the reef is much disturbed and of poor value. Up to the present twenty-four boreholes have been put down. Of these, so far as I know, only two have given promising results. The "K" hole, sunk close to the joint boundary of the farm with Kleinfontein Deep and Brakpan, cut 28 in. of reef at 2833 ft., assaying £3 7s. a ton; and the "M" hole, at 2456 ft., cut 26 in., assaying £1 15s. per ton. It seems probable that the deeper part of this property, adjoining Brakpan, will eventually be selected as the Mynpacht; but no doubt more boring will be done first.

Another boundary of this big farm marks where the Van Dyk and Rand Collieries properties adjoin it, and the favourable results in that locality would seem to indicate a payable area in Apex. A bore was sunk in this area a few hundred feet distant from one of the good holes on Rand Collieries, but with poor results. Here, too, further boring will, no doubt, be done.

The company possesses a coal-mine on its farm, with a coal of fair steaming quality, and from this source will continue to make good profits for a number of years.

Apex may be described as an interesting property. The prospecting results to date, however, have been of doubtful value.

Western Kleinfontein is a small property, and the reef is poor in it. The company has got cash, but it is unlikely that the mine will do any good.

Benoni is a large area. The upper levels, with the exception of one patch, are poor ; but I have an idea that a run of better ore is making, horizontally, and there is a chance that the lower half of the mine may be payable. It is a mine to be watched.

Chimes West is a poor mine, so far as explored. The payable area, if any, is hardly likely to be great, and in the case of good ore being met with an amalgamation with New Kleinfontein would seem to be the best move.

New Kleinfontein is a mine I like. As to size, it is officially estimated that there should not be less than 8,000,000 tons of clean ore. As to plant, it has, I consider, the best plant of any gold-mine in the world, and when running 200 stamps should show very low costs. In estimating the average value of the ore in the mine it is to be noted that there are at present over 800,000 tons in reserve, with an assay value of 37s. over a width of 46 in. This represents ore at fifteen different levels, of which the lowest are fully up to the average value of the mine. Three bores have been sunk on the immediate dip, in the ground of the Van Ryn Deep. Two of these showed payable results.

Of course, New Kleinfontein is not a rich mine ; but the prospects appeal to me as being essentially sound. The shares at $2\frac{1}{4}$ look to be under their intrinsic value.

Van Ryn is also a good mine, though probably with limitations. I refer to the possibility of the western end of the mine being badly dislocated in depth. It is not certain that this is so ; but there is need for some caution. Outside of this possibility the opening up well.

The **Modderfontein** is a large property, but has as yet done nothing to justify its heavy capitalization. The reef is patchy, but on the whole is of fair average value. I have always understood that the reef here breaks very badly to its walls, frequently as much as five feet of rock coming down in the blast, whereas the clean ore does not amount to one-third of this. A mine like this can clearly only justify its price if worked with from 200 to 300 stamps. Boreholes sunk on the dip of this mine by the Modderfontein Deep were disappointing. Finally, I do not wish to infer that New Modderfontein will not be a profitable mine, but I am sceptical of it earning relatively large profits.

Modderfontein Extension is a large property, but as yet there is no evidence that it is payable. A considerable amount of development work has been done, showing a reef rich, but narrow and badly disturbed, and the net result was not satisfactory. Five boreholes have also been put down, showing poor results. No doubt the deeper parts of the mine will now be tested. In the meantime the prospects are poor.

The large farms, **Klipfontein Estate**, **Rand Klipfontein**, and **Holfontein**, the latter the property of the **Transvaal Consolidated Lands**, in the north-east corner of the field, have been, so to speak, riddled with boreholes without any ore of much value being found. There is still a hope for these properties that within their extensive boundaries some payable patches may be found, but the weight of evidence, so far, is against them.

From here the reef turns somewhat abruptly, and, running to the south, the conglomerate-carrying formation passes under rock of later origin, which covers it to a depth of 1000 ft. From **Holfontein**, south to **Vlakfontein**, a distance of twelve miles, there is only what is termed a sub-outcrop, and the rim of the basin can in this section only be located by boring. Beyond this, on the farm **Vlakfontein**, the property of the **Lydenburg Gold Farms Company**, two bores have located the reef at 441 and at 860 ft. respectively. The values were not good.

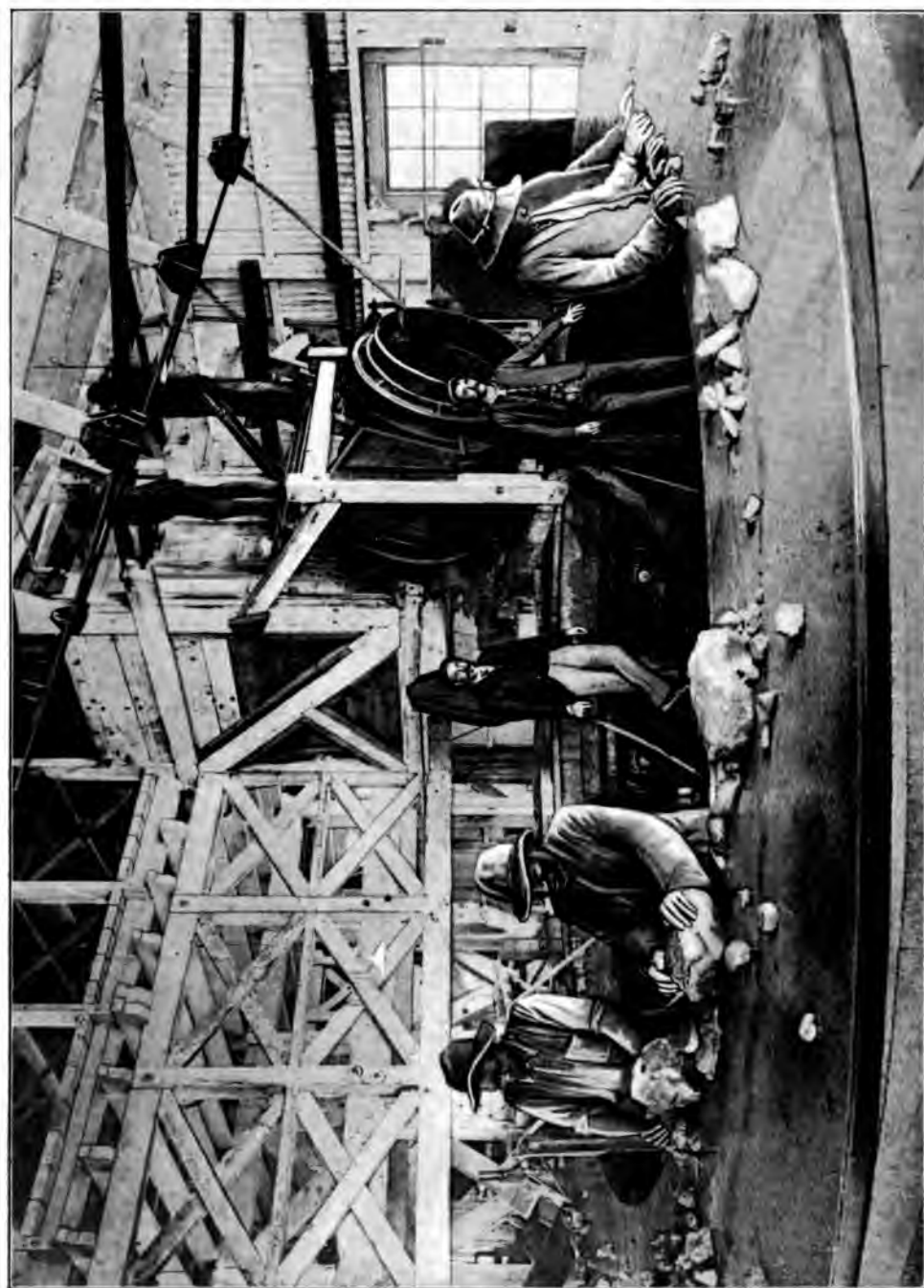
From here the reef passes into the property of the **Marievale Nigel**. In this locality it is poor and broken, and a series of nine boreholes failed to discover anything of value.

Between here and the **Nigel** the ground is poor and broken, but in that mine there are several areas of high-grade ore. Near the surface this was the richest banket mine in the Transvaal. It is difficult to estimate how much good ore there still is in this mine, for though it is a big property, the good patches are found in only a part of it. The mine will certainly do well for a number of years, but it is hard to arrive at the intrinsic value of the shares.

Beyond the **Nigel** come, on the outcrop, the **Ryan Nigel, Florida, North Florida, South Florida**, in none of which has any good ore been found. Beyond this point the reef has not yet been traced.

It should be explained that the geologists have not yet decided whether the **Nigel** reef, as shown in that mine and those on each side, is the actual reef that is worked in the mines on the north of the basin—in Modderfontein Extension or Geduld, for example, or whether it is another of the series; but that it belongs to the Main Reef series, and will shortly be defined without dubiety, seems a matter of certainty.

After the six-mile blank, commencing two miles beyond the **Nigel**—a blank which should be filled in when boring has taken place in this locality—the reef, or a reef of the series, is again shown outcropping on the townlands close to Heidelberg. The **Mines and Minerals** Company put down two boreholes on this, 500 yd. apart, and at depths of 435 ft. and 549 ft. cut the reef. In one hole the width was 12 in., in the other 31 in., and in both the value was the same—about £6 a ton. These two very good results in a district so far thought to be poor, and on the dip of ground which assayed poorly at the outcrop, are hard to understand. As in the case of the two holes on East Rand Extension, they seem out of place, and until the results are confirmed by shafts, too much reliance be placed on them.



A RAND ORE-SORTING TABLE

We may assume that at this point—that is to say, at the town of Heidelberg—the East Rand basin ends. The conglomerates do not end of course, but this seems the natural limit at which to round off the gold-field, for beyond here very little is as yet known geologically. We will now consider the deep levels of the East Rand field.

On the farm Witpoort, the deep level of the Apex, are the properties of the **Van Dyk Proprietary** and **Rand Collieries**. On paper each of these looks a good gamble, but I will not venture to say anything more definite until the ore has been opened out. Each is a large property in strong financial hands. Each has put down boreholes and got good results, and the indications would seem to point to the existence in this locality of a large patch of good ore. Of course the evidence of the boreholes is not entirely favourable. The two holes on Rand Collieries were both good; but a hole a short distance away in the Apex ground was poor. The Van Dyk had two good holes, but it also had three poor holes; and it was only by keeping one of these outside the area of its mynpacht that it was able to show, for the four holes taken into account, such a favourable average.

Still, the fact remains that each mine actually had two good holes above the average value of the Central Rand, and a big speculative value must be held to belong to each mine.

The ore in each mine should be met at round about 2000 ft. The directors of these mines will, it is to be hoped, see the folly of floating off small areas in this part of the Rand, and will decide to work each of these properties, large as they are, as units. If eventually they find that there are not many poor patches, and can run several hundred stamps on each, so much the better.

The **East Rand Central** is a triangular area of ground to the east of Rand Collieries, in which the reef probably lies at over 4000 ft. deep. It is not the right shape for a separate flotation, and should be incorporated with adjoining ground.

Brakpan Mines. This will be a deep mine, not much short of 3500 ft. on the average. Five bores have been put down on the farm to date. One of these went into disbase, but the others, although not good, gave results which justify shaft-sinking. The financial position of the company is very strong, and although a doubtful, this may be considered an interesting mine.

Kleinfontein Deep is on the dip of Benoni and Chimes West, and the uncertain prospects of those mines are reflected in it. No bores have yet been sunk, but a bore on the joint boundary of this mine and Apex, at 2833 ft., showed 28 in. and a value of £3 7s. a ton. The nearest bores in Brakpan and in Van Ryn Deep were also not unfavourable evidence.

Van Ryn Deep, as the deep level of such a sound mine as New Kleinfontein, has certainly prospects. Its own bores, too, are favourable. No. 1 (sunk many years ago, when this was called the Chimes Mines) cut the reef at 1754 ft., worth £3 6s. a ton, over 36 in.; No. 2, at 2287 ft., cut 7 in., worth £4 4s., and at 2319 ft., 3 in., worth £4 15s. a ton; No. 3, at 1545 ft., showed 36 in., worth £1 18s. a ton. I expect to see this turn out a valuable mine, but in the meantime no definite valuation is possible.

Modderfontein Deep put down three boreholes, with these results:

No. 1. At 2967 ft. several stringers of reef, averaging £1 5s. a ton over a stoping width.

No. 2. Sunk to 2781 ft. Abandoned in disturbed ground.

No. 3. At 2803 ft., 12 in. ore assaying £3 4s. per ton.

These results are not strikingly good, but no doubt shafts will be sunk.

Below here is the large area belonging to the **Transvaal Lands and Mines Proprietary**, a semi-private concern. No prospecting has been done.

The **Geduld** farm shows some of the marked characteristics East Rand—that is to say, a single, narrow reef, lying ver-

Two boreholes out of three gave excellent results. The Proprietary Company has floated off two subsidiaries, and proposes to float four more from the ground remaining to it. I think, personally, that it would have been better to have worked the whole as one large unit, with one central plant. No doubt there is an area of good ground here, although the results of three boreholes is not much in the way of evidence. On the other hand, these claims carry a very small tonnage, and can be quite easily over-capitalized by a public educated up to the claim tonnage of the Central Rand.

The **Geduld Deep** is hardly a large enough area to work separately. It would seem to be well located, however.

The **Cloverfield** farm is in a doubtful area, although that part of it adjoining Geduld might turn out to carry payable ground. A borehole on this part of the ground cut the reef at 1979 ft., 17 in. wide, and worth £6 10s. a ton. The other bore, on the area removed from Geduld, got the reef at 2990 ft., 4 in. wide, worth £4 4s. a ton. The prospects are problematical.

On the farm of the **Welgedacht** Company six boreholes have been sunk, and all show poor results. These tally with similar results on Klipfontein and Holfontein, and lead to the belief that a big area in this north-east portion of the basin is very poor.

On the farm **Geygerle** no boring has yet been done. It lies in a doubtful area. On the farm Droogfontein, belonging to the **Lace Proprietary**, four holes have been sunk, cutting the reef at moderate depths. The values from these have not yet been stated, but are thought to be poor.

The farms Palmietkuil and Grootvlei are controlled by the **East Rand Mining Estates** and the **Grootvlei** Company. The bores as yet sunk on these show a very narrow reef and poor values. The **Daggafontein** Company has also exposed similar conditions on its farm.

The **Clydesdale** and **Cassel** Collieries, working a coal seam in one corner of Daggafontein, also own the gold-mining rights. A joint bore-hole, put down on the Cassel ground, proved the reef to lie at a vertical depth of over 4800 ft., and the value was poor.

The gold rights of the farm Rietfontein 164, where coal is being worked by the Transvaal Coal Trust Company, have been sold by that company to the **Eastern Exploration Company**. Two bores have been put down. In the northern hole the reef was cut at 3478 ft., 18 in. wide, and worth about £6 a ton. In the southern hole the reef was found at 3617 ft., 11 in. wide, worth £4 10s. a ton. These are promising results, and lead me to think this area may carry the continuation of the run of good ore which presumably exists in Geduld.

South-west from this farm are the farms Vlakfontein 26, belonging to the **Lace Proprietary Mines**, and Withoek, owned by the **Withoek Proprietary**. These probably represent the deepest part of the East Rand basin, and no boring has as yet been done here.

The deep-level areas in the Nigel section are owned by the **Henderson Nigel, Transvaal Nigel, Nigel Deep, Central Nigel Deep, and Sub Nigel**. Below these again the farm Grootfontein is owned by the **Consolidated Goldfields Company**.

It is probable that if there is any payable deep-level ground in this section, it is that immediately below the Nigel pay-chutes; and Nigel Deep, Nigel Central Deep, and Sub Nigel are the only areas that may be considered hopeful. The ore in Nigel Deep is very narrow, and that mine, which has been developed considerably, must as yet be looked on as barely payable. But all these three mines are large properties, and not without prospects. On the border of Central Nigel Deep and Grootfontein a borehole was sunk 3000 ft., and several holes were also sunk on Sub Nigel. The results of all these were, I believe, poor. The other farms between Nigel and Heidelberg, and on the dip, have not yet floated.



THE RAND--LOOKING EAST FROM JOHANNESBURG

Beyond Heidelberg little is as yet known about the conglomerates, and the precise direction they take before reaching and crossing the Vaal River can only be guessed at. It is known that there are several reefs in this district, but no correlation has been worked out. All that is yet known is disappointing. The reefs are poor, faulted, and almost invariably narrow, and if the district carries large patches of payable ore, it has not yet revealed these.

Tiny patches of good ore have been found from time to time along this line—at the Molyneux, now the **Nigel Proprietary**, at the **Coronation**, at **Hex River**, and at **Heidelberg Roodepoort**; but these patches have never been found to extend to such an area as to be commercially valuable. Other mines in this district are the **Boschoek Proprietary**, **Blinkpoort**, **Houtpoort**, and **Daspoort**. On the latter company's ground I understand that a borehole showed fair values; but, as in the case of the bores on the Heidelberg Town lands, it would be safer to confirm this by shaft-sinking before taking the result as assured.

At one time great things were expected of the **Coronation** line of reef. I visited the main workings of this company, and was surprised to see on what small evidence the market value of the mine had lately risen to a capitalization of £4,500,000. The reef, as usual in the district, was only a few inches wide. Worse than this, it was terribly faulted, and every few feet would jump from the floor to the roof of the level. Stopping would have been most difficult. Finally, after continuing for about 350 ft., the reef was faulted at each end of the mine, and had disappeared. The capacity of a mine like this, allowing the ore to continue in depth, was about five stamps, and I should not like to have the working of it. This was the mine that had become famous.

I do not mean to say that the large property of the Coronation Company has no chance of success, but it seems common sense to find the pay-ore first and put up the shares afterwards.

On the western end of the Central Rand, beyond Randfontein,

the reef series is lost for a few miles. Adjoining Randfontein is the farm Middelvlei, on no part of which has the main reef series yet been exposed. Some mines here were started to work the Black reef, but have done no good. These properties might have prospective value if the main reef series were located on the farm; their names are **Middelvlei Estate**, **Middelvlei Deep**, **Midas Deep**, and **Midas East Estate**.

Beyond Middelvlei all the ground for a number of miles is owned by the **Western Rand Estates**, in which property the reef has again been located. Up to the present ten boreholes have been put down, and the three holes on the farm Gembokfontein cut the reef at an average depth of about 1900 ft. Two of these gave good results.

No doubt in years to come this area may become a second Randfontein, and it certainly has promise. In the meantime it is as well to remember that very little is as yet known of its possibilities; that a great deal of money must be spent; and that it cannot produce for a number of years. Some engineers fear that as the reef here lies under a bed of dolomite, water trouble may be looked for when shaft-sinking begins. This could no doubt, however, be overcome.

From this point to the neighbourhood of Klerksdorp nothing is known of the value of the conglomerate.

At the back of the main reef series, along sections of the Rand, the Du Preez reef outcrops. On one of these bits of outcrop the **Rietfontein Estate**, **Rietfontein A**, and **Rietfontein B**, now reamalgamated as one mine, are at work. This is a narrow reef, often only an inch or two wide, but considerable patches of it are of high value and yield good profit.

However, I do not believe in a high capitalization for this property. There is evidence that the reef is not permanent in depth, but is rather a broken off or faulted bit lying away from its true position. Boreholes put down have confirmed this theory; for some the formation was come upon lying quite flat, and in o

there was no ore at all. As I have said, there is rich ore here ; but the future is uncertain, and there is reason to exercise caution.

The Klerksdorp section of the great conglomerate basin, which will no doubt some day be linked up with the Witwatersrand, begins with the **Buffelsdoorn** group of mines. I do not think the prospects of these are favourable.

The Klerksdorp district, generally speaking, carries fairly large reefs. On the average these are of unpayable value ; but there are considerable areas which should yield between 15s. and 20s. a ton.

Not this year, or next, but perhaps in ten or fifteen years, ore of this value, and in the quantity which I believe exists round Klerksdorp, may be within the horizon of payability ; therefore the numerous reefs on this field seem to have a dim prospective value which I would not assign to large sections of the East Rand basin nor to the Heidelberg district.

In the meantime none of the mines are doing much good. The properties on the Eastleigh line are in liquidation, but the old Eastleigh mine itself, with care, should be worked at a profit. The **Niekerk** is a small patch, so far as is known, and though rich in places, is not likely to make big returns.

The **Klerksdorp Gold, Klerksdorp Proprietary, Klerksdorp Extended, Rietkuil, Rhenoster Mines**, and others, conform to the low-grade type. In fifteen years it may be possible to speak of such properties more favourably.

Beyond Klerksdorp the rim of the conglomerate basin is supposed to cross the Vaal River into the northern part of the Orange Colony, where it connects up with the reefs coming from the Heidelberg district. But the prospecting of this section of the basin has yet to be done.

In the western districts of the Transvaal—at Schweizer Reinecke, Malmani, and Otto's Hoop—quartz-reefs are known, but nothing of commercial value has yet been found.

There is a big stretch of country in the east and north-east carry-

ing scattered quartz-mines. These are found over such distant centres as Pigg's Peak, De Kaap, Kantoer, Pilgrim's Rest, Murchison, Klein Letaba, Woodbush, Pietersberg, and Spelonken. The Gwanda and Victoria districts of Rhodesia form, no doubt, a continuation of this run of country. The quartz-mines of the Transvaal—and there have been some hundreds floated at one time or another—have been a ghastly failure, and those who now knowingly buy shares in this class of venture deserve to lose their money. If any one wishes to develop a mine of this type, with his eyes open, there is no objection to such a course, for money spent on actual prospecting or development work is always a legitimate venture. But if, instead of putting money into actual exploratory work in these districts it is merely put into some company promoter's watered scrip, the chances of any profit become infinitesimal.

I do not wish it to be inferred that no payable quartz-mines are going to be found over this big area, for as yet it has not been thoroughly explored. But it is correct to say that not one quartz-mine of assured value is known at present, and I could not name one that I feel hopeful about.

The best quartz-mine up to the present has been the **Sheba** at Barberton. To-day the Sheba looks to be bottomed; indeed, as far back as 1899, when I last inspected the mine, no payable ore had been exposed in the four lowest levels. It is possible that the mine can be kept running for some time longer on ore from the shallower levels, but unless new deposits are found there will be no future, and no dividends. The mine has paid dividends in the past of over £700,000, but the greater part of this was put into it first as equipment. It would have been a valuable mine worked on a small scale, but in the attempt to work it like a big Rand mine, ignoring the fact that a quartz-reef cannot be figured out on this cut-and-dried basis, it may fairly be described as having been "butchered."

The other "Sheba" mines, so far as I know, are not valuable. I am afraid no mine in the De Kaap district shows assured prospects. The small patches of rich ore, found in a number of do not go deep enough to make them of any commercial

The district must not be looked on as absolutely hopeless, but the weight of evidence is against it up to the present. Other mines at De Kaap are the **Moodies'**, **United Ivy**, **Clutha**, **Woodstock**, **Worcester** (transferred here, after selling its Rand property to the Ferreira), **Albion**, **New De Kaap**, and **Cataract**.

The **Pigg's Peak** mine in Swaziland is stated to have prospects, but not enough development has been done to justify any statement yet.

At the Kantoor, thirty miles from Barberton, are two small producing mines, **Barrett's** and **Coetzeestroom**. Their prospects are doubtful.

The Pilgrim's Rest field of the Lydenburg district is to be distinguished from the other centres of this part of the Transvaal in that most of the mines there work an interbedded, water-laid—not a quartz, formation. The chances of gold extending with some regularity, when found in these Pilgrim's Rest reefs, are better than the chances of the same happening in a quartz-mine. I would therefore single out this among the outside districts of the Transvaal as likeliest to repay intelligent exploration. The best mines found near Pilgrim's Rest have been **Transvaal Gold Mining Estates**, and **Glynn's Lydenburg**, and the latter of these is probably, at the present time, the only non-banket mine in the Transvaal with sound prospects. I believe there is ore in sight in Glynn's to last for five years, on the present basis of profits; and the more distant prospects are hopeful. The shares, standing as they do at over £2, do not show the necessary two-thirds of profit in sight. The prospects of the Transvaal Gold Mining Estates, are not so favourable. The **Spitzkop**, **Graskop**, and **Lisbon-Berlyn** companies own big areas in the Pilgrim's Rest neighbourhood, but the reefs on them are poor so far as known. Other mines of the Lydenburg district have not yet found payable ore.

The developed quartz-mines in different parts of the Zoutpansberg district are all unpayable, so far as is known, although there is room for a great deal more explanation before it can be definitely said that the district is no good. The small, rich patches in the

Klein Letaba, worked in the case of the Birthday, Ellerton, Letaba, and Ella, have shown themselves to lack commercial value. Round Pietersberg, too, and at Smitsdorp, Marabastad, and Woodbush, the same result is shown. It is now stated that one or two favourable prospects are shown north of Pietersberg, in Magato's country, and in the Spelonken, but I shall be sceptical till any of these mines reach below a depth of, say, 400 ft.

The Murchison Range has got defined reefs running for a number of miles. The climate there is of the worst ; and as for the gold, it is more than elusive in its occurrence. The usual small rich patches are in evidence, and there is reason to think that small parties of working miners, with a portable three or five-head mill, might earn a living in the healthy season ; but as to the success of large concerns, relying on a continuance of pay ore in depth, I shall believe it when the gold is actually produced.

CHAPTER VIII

THE GOLD-MINES OF RHODESIA

LONG before the greatest Englishman of his time added to the Empire the country we now call Rhodesia, he had said it was full of gold. I have often wondered how he knew this. He had never been there ; few people had been, and the observations of hunters and travellers are doubtful evidence where gold is concerned. The existence of ancient workings, as I show elsewhere, cannot be held to indicate with any certainty the presence of payable mines.

But he knew. Rhodesia is full of gold. There are in that country hundreds, perhaps thousands of gold-bearing reefs, and in this respect Rhodesia may be held to rank with the most highly mineralized parts of the world.

The Chartered Company, brought into life by this great man, furthered by his millions and the liberal support of its shareholders, has done a big work in Rhodesia since 1890, and is still doing it. Nor would I neglect to mention the settlers in the country. They have fought three wars ; they have had to fight fever and drought ; they have lost their crops by locusts, and have seen their herds decimated by disease. Yet all the time, amid war, pestilence, and famine, prospecting has been bravely carried on, and one way and another over four millions of gold have been already won. More wonderful than all seem to me the railways of Rhodesia. For in this new and desolate country, where as yet the white population numbers only 12,000, there are nearly 2000 miles of railway open, which have cost nearly £8,000,000 to build. To-day

most of the principal mines have sidings running to their very doors, and the scheme of construction is still being carried on.

The master mind of its founder, the millions poured by the Chartered Company into development, and the energy and resisting powers of the settlers, were forces exactly adapted to the great work to which they were set; and I say advisedly that in Rhodesia we have the finest example of opening up a new country the world has yet seen.

And what is the result of it all—the practical result so far as the gold-mines are concerned?

The result of all the mining development done to date in Rhodesia has gone to show that there is a great deal of gold in the country, and that it is widely distributed; but that in most cases it is not found in sufficiently concentrated qualities to yield any real profit. One may go further and state that up to the present most of the mines have worked at a loss.

It is the old story. Gold-mining is a serious business. If we are to get profit from our gold-mines, we must see that they are initiated and run by trained men. The pioneers of Rhodesia, for all their pluck and hardihood, were not practical mining men; they were amateurs where mining was concerned, and for the matter of that still are. These people, however, were entrusted with millions of money by the English Public, and did with most of that money just what might have been expected of inexperienced people;—they spent it to poor advantage. Their so-called technical advisers were men of almost as little experience as themselves, and by the time sound engineers came to the country to settle, the mischief had been done.

The mine-valuer, must have no sentiment. As a Britisher I admire and have drawn attention to the splendid way Rhodesia has been opened up by my fellow-countrymen. As a miner, I have to say that millions have been spent unwisely, that most of the mines opened so far do not show signs of permanence, that the cost of most of these was never justified, and that the outlay



RAILWAY MAKING IN RHODESIA

the country as regards gold-mines is not a bright one. I must not be taken to say that the outlook for Rhodesia as a gold-mining country is hopeless. It is not that; but it is sufficiently bad to frighten those who know most about it.

It will be noted that of Rhodesian mines floated in London the greater number are essentially small mines, which have a capacity of just about ten stamps each.¹

Noting this significant fact, I propose to discuss what may be called the "psychology of the ten-stamp mine"; and I would ask the promoter of Rhodesian Companies to ponder over this subject.

When a new gold-mine is discovered anywhere, and the time comes for it to be equipped with machinery, its owners or directors ought not to decide in an arbitrary manner whether it shall have ten or fifty or a hundred stamps. The mine's capacity, the amount of ore it can put out daily, or monthly, or yearly, is governed by such factors as the width of the reef, the length of the pay-chutes, and the probable or not probable persistence of the lode in depth. If the mine shows a big ore-body, and a long run of pay-ore, if it is developed for several levels ahead, and if the indications in depth are favourable, it is easy to see that a production of 50,000 or 100,000, or it may be 200,000, tons of ore can be put out yearly. In this case the engineer has no hesitation in recommending the directors to put up forty or eighty or a hundred stamps, for he sees his way to develop ore as rapidly as it can be taken out. But on the other hand, if the mine is clearly turning out a small one, if the reef is only 2 ft. or 3 ft. wide, and if the ore-chute is only perhaps

¹ A casual estimate of Rhodesian mines shows that, of fifty-six I have record of, no less than thirty-five are small mines, whose capacity in the average did not justify the erection of more than ten stamps. Here are the names of these thirty-five mines:—Christmas Reef, Criterion, Red and White Rose, Matabele Sheba, Anterior, Dumbleton, Jessie, Eagle Vulture, Imani, Lone Star, Butterfly, Inez, Battlefields, Alice, Bernheim, Beatrice, Rezende, Gaika, Dunraven, Theta, Guinea Fowl, Kimberley, Moonie Creek, Rose of Sharon, Gatling Hill, Dobie, Sabi, Nelly and Pioneer, Golden Valley, Queens, Morven, Confidence, Leopard, Selukwe Columbia, Ophir.

300 ft. or 500 ft. long, it is clear that the whole thing must be judged from a different standpoint, and a small mill, in keeping with the small size of the mine, will be determined on.¹

It is no uncommon thing for the narrow, gold-bearing quartz-reef to be unusually rich at the surface. This concentration of values is due to secondary enrichment. More often than not such enrichment is local, limited to perhaps a depth of 100, 150, or 200 ft., and is not liable to deceive the experienced engineer. But the ancients, whoever they were, who worked in their primitive fashion the mines of Rhodesia, did not worry their heads over secondary enrichment, or the deposition of metals from percolating solutions. In those days recondite systems of mine-valuation were unknown, and the preference for big low-grade ore-bodies was not voiced by the cognoscenti. The miners attacked the rich little reefs, where visible gold was showing, with greater zest than the big, poorer reefs, and as they had to stop work when the water level was reached, the fate of these reefs in depth was to them a matter of unconcern.

At the time duly appointed by destiny the pioneers entered Rhodesia. They found, by the hundreds of old workings scattered over the country, that their prospecting had already been done for them. As I have said, the pioneers were not expert judges of gold-mines. Had they been, they would have noted how many of the reefs worked by the ancients were narrow, and how short were most of the pay-chutes. They would also have realized that this small, rich type of mine, though it appealed to the ancients, lacked the essentials of permanence, and was not the right sort of mine to float into a public company. An experienced mine-valuer would have pointed out the exaggerated value which the ancient workings had given to this type of mine; he would have shown the probable limits of their areas; he would have estimated

¹ It is to be noted that the most profitable gold-mines are usually big, low-grade deposits, rather than small, rich reefs. Other things being equal, the professional miner always favours the former class of mine in preference to the latter.

the big cost of equipment relative to the probable ore-contents, and the unlikelihood of any real profits being earned; and finally, he would have tried to turn attention to the bigger and lower-grade mines in preference.

Such a prophet, no doubt, would not have been listened to. The pioneers, after all their hardships, were determined to have a "boom," with the small mines they had already developed—and there was a boom. I do not blame them for this; but I had hoped by this time they themselves would have realized, which they do not seem to have done, the inherent fallacy of these small, rich mines, and the harm their continued flotation has done to the good name of Rhodesia.

It may seem hard to the owner of one of these small mines—whether that owner be an individual or an exploration company—that its flotation cannot be looked upon as a justifiable act. There may perhaps be 30,000 tons of good ore developed; the bottom of the mine may be looking well; and the public may be "on the feed." But the weight of evidence against the ultimate success of 95 per cent of these small mines is overwhelming. If the owner sets his selfish interests up as of more account than the good name of the mining industry, and of his own good name in the future, he will float the mine, and perhaps be able to sell out his vendor's scrip. But it is almost certain that the mine will come to an end before it has paid off its capital, plus interest on that capital; and the people who have bought the shares will therefore lose their money.

I have said that the evidence against the ultimate success of the small mine, especially the small Rhodesian mine, is overwhelming. In order to give some precise figures on this point, I will analyze the results of the thirty-five small Rhodesian mines already referred to.

- (1) The average issued capital of such of these mines as at present exist as separate companies is £136,000.

- (2) The average cash outlay on each cannot be stated, for some have not yet been equipped, and others never will be. The Rhodesian Chamber of Mines report for 1903 gives the cash outlay on four of these mines as follows :—

Name.	No. of Stamps.	Cost of Equipment, etc.	Remarks.
Anterior . . .	10 ...	£84,530 ...	Worked to date without profit.
Imani . . .	10 ..	65,000 ...	Shut down; without profit.
Red and White Rose . .	20 ...	81,200 ...	Worked without profit; now let on tribute.
Rezende . . .	20 ...	86,537 ...	Worked over 100,000 tons to date, with no profit.

It will be noted that two of these mines have twenty stamps each. They are both, however, essentially small mines, of the "ten-stamp" type. The average cost of developing and equipping these four mines is shown to be £79,000. There is not one small gold-mine in a hundred that can be expected to return such a sum as this in profit, to say nothing of interest on the capital outlay, and on the vendor's scrip.

- (3) Of these thirty-five small mines, twenty-two seem already to have gone wrong altogether in depth. In twenty cases the reefs either died out, or lost their gold, and in two cases they bottomed on granite. A number of the others look shaky. One of these thirty-five mines has paid small dividends, and perhaps four or five, all told, will earn some profit ; but in no case is one of these mines likely to pay back the money put into it, let alone to earn profit on the vendor's shares.

The small gold-mine, when floated into a public company, is the worst enemy of the engineer or mine-manager, and the weight of the mining profession should be thrown in the

against this sort of procedure. As I have shown, a mine of this sort is rarely successful, and it is no advantage for a consulting engineer or manager to have his name associated with a failure. But that is not all; for if the mine is a failure, shareholders lose their money, and withdraw their influence from gold-mines; a blow is struck at the prosperity of the mining industry, and it is in the prosperity of this industry that our future is bound up. I think that after this the promoter who floats a "ten-stamp" type of mine in Rhodesia or elsewhere, for a capital of more than £25,000, should be arraigned before the Council of the Institute of Mining and Metallurgy, charged with dealing a blow against the good name of the mining industry, and that permission be given to the brawniest member present to emphasize these remarks with his boots—just by way of levelling things.

The purely technical side of the small type of mine remains to be considered. The technical description of such a mine would be "a narrow reef and a short pay-chute, or chutes, of normal value." The experienced mine-valuer knows this sort of mine to his cost; he does not ask for a more detailed description. But for the younger man, who is new to mine valuation, let me say that such a reef might average 3 ft. or 4 ft. wide, that the pay-chutes might aggregate anything up to 600 ft. in length, and that a normal value may mean an actual recovery of gold of 45s. per ton.

For the sake of illustration, let us assume a mine of just such dimensions. Let us assume a reef 4 ft. wide; two pay-chutes, one 450 ft. long, the other, 150 ft. long, separated by 200 ft. of poor ore—aggregating 600 ft.; a recovery value averaging 45s. a ton; and the mine developed to the 100-ft. level. This is a better mine by far than the average of the thirty-six small Rhodesian mines we have been analyzing; but as it is strictly of the "ten-stamp" type, I can make my arguments the more forcible.

The inexperienced, untrained man, asked to report on such a mine for flotation, would be able to present a plausible statement. He would say this: "I have sampled the 100-ft. level, where there is

600 ft. of pay ore, with a width of 4 ft. This gives 18,400 tons to a level, so that down to 1000 ft. the mine may be estimated to produce 184,000 tons. The value averages 45s. a ton; recovery and total costs ought not to be more than 30s. a ton. The clear profit per ton will therefore be 15s.; and on the 184,000 tons estimated to exist above the 1000-ft. level the total profit should be £138,000."

This report, which the inexperienced and characterless young man no doubt considers a weighty document, worth far more than the 500 guineas he is paid for it, is, of course, not only valueless in its technical advice, but is a document destined to bring the mining profession into disrepute. The promoter, who knows something about mines, reads it with his tongue in his cheek. He realizes that he has secured a scapegoat, on whose head he can eventually divert the public wrath; and he proceeds to float the mine for £100,000, making a large profit on the deal.

Now let us see how the experienced mine-valuer would have summed up this mine. At the 100-ft. level he would see, as the other man saw, 600 ft. of pay-ore 4 ft. wide, of a recovery value of 45s. per ton. But he would be less under the influence of his imagination. If the ore stood intact to the surface and had been blocked out by several winzes, he would call that in his report "ore blocked out," and he would add to it perhaps 50 ft. of ore, 600 ft. long, below the first level, as the margin of risk which was justifiable to allow for. His ore-reserves would figure thus:—

Blocked-out ore above first level	. 18,400 tons.	
Less mined by ancients, say, .	. 8,400 „ ...	10,000 tons.
Assumed ore below first level.	. 9,000 „	
	Total	19,000

Assuming 15s. per ton clear profit, this would represent a net profit in sight of £14,250, less the cost of equipment, and the experienced man would not pledge his name to a higher figure than this for all the promoters in christendom. The mine might

floated on its general prospects in depth ; it probably would be if the promoter were a resolute man ; but it would be on the clear understanding, so far as the engineer was concerned, that the undertaking was a speculation, and that no blame was to be attached to the mining profession if it failed.

Now let me try to picture the probable actual area of this mine in question, and show how essentially the trained and experienced man would be justified in the sort of report he would write.

A gold-mine, from the very nature of the deposition of the metal, will become poorer in depth. When the mine in question is a quartz-reef and there has been a probable secondary enrichment, the tendency to impoverishment is accentuated, though just where the falling-off in value will begin one cannot say. The first level of such a mine is no criterion whatever of its real value. Again, this mine in question is assumed to have pay-ore only 600 ft. in length, and the mine-valuer knows that it is not usual for a pay-chute to extend farther in depth than in length. The experienced man, when summing up the chances of a mine of this nature, would expect in his own mind to see the chute die out before reaching 600 ft. Especially would he think this when he noted that the pay-ore, as shown at the first level, was not in a continuous chute, but split into two, and that the longest section was only 450 ft.

The mine-valuer might not say these things in his report, for ore-chutes are phenomena which do not lend themselves to exact statements, but if he had noted carefully the history and death of some hundreds of small mines, and had made measurements whenever possible of the relation of length to depth of their ore-chutes, he would be able to make an astonishingly good guess at the true area of the mine under consideration, and would word his report in a way which would be unlikely to mislead the public.

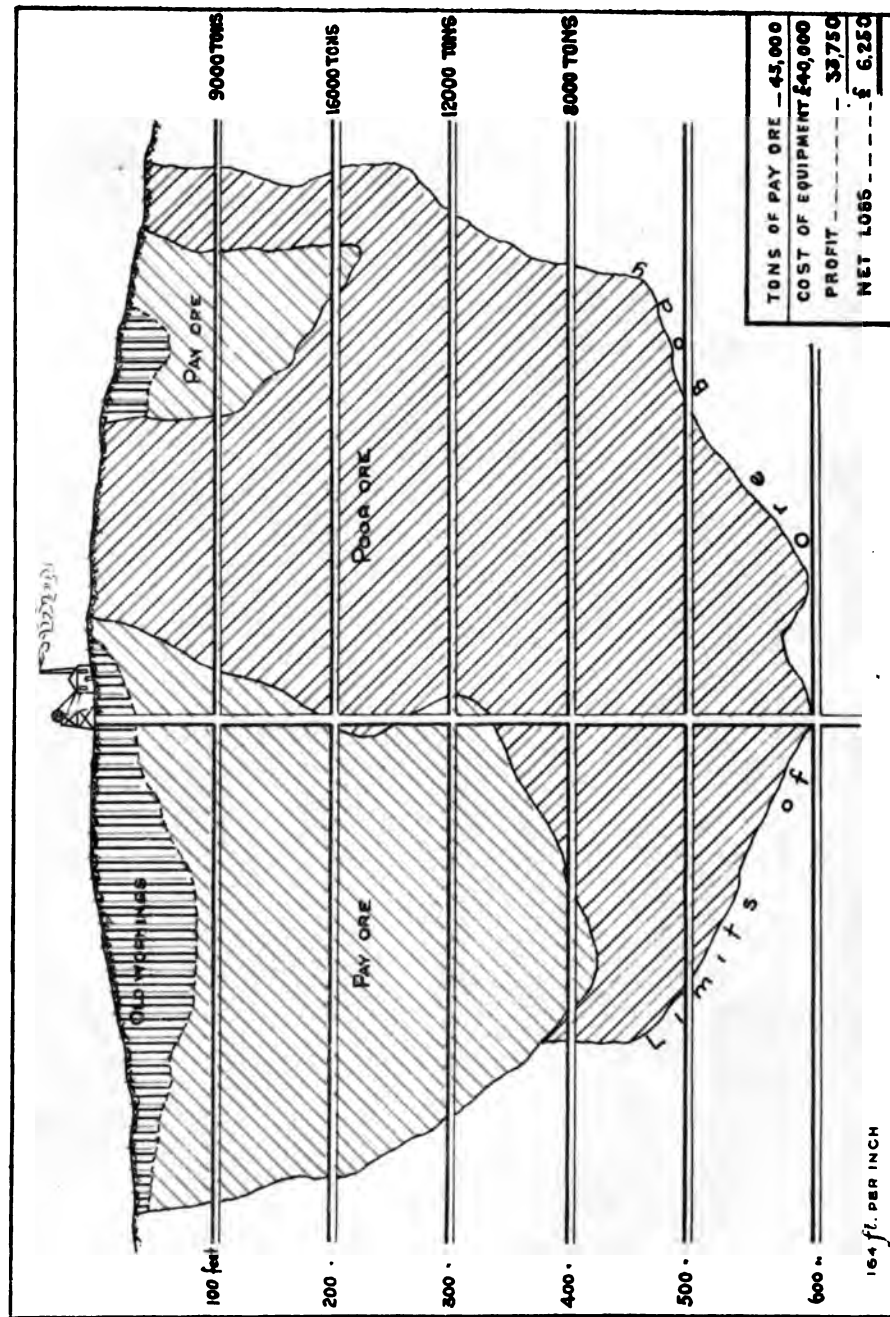
I say that the mine-valuer of experience—although naturally unable to see farther into the ground than any one else—would be able after an examination of this mine to make an astonishingly good guess as to its true area and value. This mental estimate of

his might be wrong in details, but it is highly probable that the general conclusions arrived at—i.e. that the pay-chutes would die out at a moderate depth, that the total ore in the mine would not exceed, let us say 50,000 tons; and that the mine would not be able to pay back the cost of development and equipment—I say that it is highly probable that these conclusions would be correct, and that the comparative accuracy of his deductions would be proved in the course of working the mine out. I have drawn and show here a plan of this assumed mine. Its first level shows 600 ft. of pay-ore, which averages 4 ft. wide, and the estimated profit is 15s. per ton. With the experience of a few hundred small mines to guide me, I have projected the pay-chutes in depth in a way they might be expected to run, and have calculated the total quantity of pay-ore in the mine and the total net profit it might be expected to produce. The result shows a dead loss.

That, then, is the “psychology of the ten-stamp mine”; we have turned this sort of mine inside out, and we find it has no soul. Look at it how you will, there is hardly one in a hundred that will return the cash spent on it plus interest, and its flotation into a public company for £150,000, or £100,000, or even £50,000 cannot be looked on as a right-minded action.

There is one condition under which the small gold-mine may be floated. It is, that its capital must be very small indeed. In Victoria, the home of this class of gold-mine, lots of small mines are floated locally, but they invariably have a capital commensurate with their size. If the mine grows, the capital can grow with it. In Victoria, a small mine with a big paid-up capital could never be floated. No one would subscribe to it. Mines are started there with from £1000 to £5000 cash and a relatively small vendor's interest, and if they cannot show encouraging results on this before asking for more working capital, they are allowed to drop out altogether.

The maximum capital of the small Rhodesian mines, in the interest of the vendors of the Chartered Company, should be



TYPE OF RHODESIAN '10 STAMP' MINE.

£25,000, whereas the average capital of the small mines that have been considered is £136,000. I say that the average capital of the small Rhodesian mine should be £25,000 all told; but it will be called to mind that the official figures of the Rhodesian Chamber of Mines, dealing with four of these properties, showed the actual cash spent on their development and equipment averaged £79,000 per mine. Let us assume that these figures are in excess of the normal. Those equipments were put up before the railways arrived, and in the days of extravagance, and no doubt what then cost £79,000 per mine could be done to-day just as efficiently for £40,000. But even here is a huge discrepancy. Theoretically, a small mine in Rhodesia should have a maximum capital of £25,000, while actually it is seen that it requires £40,000 for working capital, to say nothing of the vendor's or Chartered Company's interests. Only one conclusion can be drawn from this. The small Rhodesian mine is not a legitimate flotation at all, even if the vendors and Chartered Company were to take their interest in deferred shares. If the owner of such a mine cannot see his way to work it privately, with a cheap equipment, he should let it out on tribute. But he ought not float it into a company.

I noted with appreciation the fact that a lot of mines in Rhodesia are now being worked on tribute. Some of these are of the "ten-stamp" type, which had failed as public companies. Some are of a bigger type than this, which had also failed under big staffs and costly boards of directors, and some are little odds and ends of mines which no one ever had the nerve to float at all. This sort of mining is the best fate that can happen to the country. The tributor can work a grade of ore that no one else could handle profitably, for he is his own manager, secretary, head office, and board of directors rolled into one, and he, or a member of his little syndicate, represents the whole official hierarchy of the mine, and perhaps the whole of the white employees. In the old days the Exploration Companies loaded themselves up with ancient workings which they had no money to develop, and in this way locked up nearly the

whole mining area of Rhodesia. But to-day adversity has taught them that greed does not pay, and they are handing their most hopeful looking mines to the tributor, with his three or five stamp mill. In this way some good new mines might be discovered, and in any case there will be more trade, and the gold output of the country will go up.

When I was last in Rhodesia, in 1904, the future of the gold-mines, with whose future the whole country is so wrapped up, was exercising many minds. Repeated failures among the already floated mines had had the natural effect in London, and nearly all new ventures and exploratory work were at a standstill for lack of money. A section of the mining community had attacked the Chartered Company, alleging that its bad government was to blame; while others denounced the Company's lien of 30 per cent on vendor's scrip as the root of all the trouble. But the depression in the Rhodesian mining industry is due to more natural reasons. It is due to the facts which I have been pointing out in this chapter. These facts are: first, that the people who found themselves in control of things knew nothing about gold-mines; second, that they floated, one after another, mines which were too small to pay; third, that they continue to do so at every opportunity. The Chartered Company has no doubt made mistakes, and has certainly been extravagant; but I consider it has done a great deal for the country. Its "30 per cent" clause may appear objectionable to the company promoter, but, as has been pointed out, these small mines would still be unpayable as public companies, even if the Chartered Company took no shares at all. The Rhodesian mine-owner, whether resident out there or in London, must understand that public confidence has been withdrawn from him because of his own faults, and until he begins to offer the public value for its money, it will remain withdrawn.

The future of Rhodesia is bound up with a bigger class body than that we have been analyzing. The small type

is in the majority, and has, so far, had the most money spent on it, but we already know of a number of bigger, and of some very big ore-deposits, and although most of these are, naturally, low-grade, I think their prospects are quite as good as one can hope for.

Of distinctly big ore-bodies—mines at the other end of the scale, as regards area, to the “ten-stamp” type—I know of eleven: Jumbo, Plum, Giant, Sabiwa, West Nicholson, Penhalonga, Falcon, Athens, Ayrshire, Wanderer, Tati. These vary in width, but they are all essentially big. The Penhalonga, averaging about 8 ft. wide, is probably the smallest, and the Plum, which is not less than 150 ft. wide, is the biggest. Some of these ore-bodies are of desperately low-grade, and one can only hope for, rather than expect any profit from them; but they give evidence that there *are* big lodes in the country, and together with the more moderate-sized lodes—as apart from the really small lodes—give some promise for the country’s future.

In a general survey of Rhodesia’s mines I shall begin with the Jumbo, which may possibly turn out to be the largest mine yet discovered in the country. This is in the Mazoe district, thirty miles north of Salisbury. The Mazoe is highly mineralized. Two miles from the Jumbo is the Plum, where there is a gold-bearing reef 150 ft. thick, and there is also another very big formation, the name of which is, I think, the Winchester. Within half a mile, I saw two “five-stamp” mills at work, and the Alice and Bernheim mines are visible on an adjacent hill. If these Mazoe lodes carry their values in depth, this might become a great mining field, but the district has not been developed yet to the point when one may speak with any authority.

The **Jumbo** mine, a quartzite, lying in schist country, and carrying plenty of mineral, has been opened out to 500 ft., on the incline, and the ancient workings reach down for 100 ft. The ore so exposed had not at the time of my visit been blocked out by winzes, but it seemed to me to average probably 30 ft. wide, and to extend for a greater distance than the 1200 ft. then driven along it. A

mine of these dimensions could work ore yielding 20s. a ton at a profit, and an analysis of the assay plan showed that probably two-thirds of the length then opened out—say 800 ft. or 900 ft.—would eventually prove profitable. If one could be sure of the Jumbo carrying its value in depth, it might be described as a fine mine, but the values are too irregular to be reassuring.

The first level is driven at 250 ft. on the incline. Along a big stretch of this level the ore is narrow, but of high value, and the average of the whole level is good. On the second level, at about 500 ft. on the incline, the lode is much wider, but the persistent high values of the level above have given place to long stretches assaying about 30s. a ton and considerable lengths assaying less than 20s. The average of the second level is distinctly low-grade, but, of course, is quite good enough if it could be relied on to continue. Pending the sinking of the shaft, and the opening of another level, one dare not say what the future of the Jumbo will be. The marked falling-off in value between the first and second levels would lead one to think that the mine is getting rapidly poorer, and that on the third level it will have become quite unpayable. On the other hand, noting the length of the pay-chutes, the highly mineralized nature of the ore, and the considerable regularity of the assays along big stretches of the second level, one is led to hope that these values may be persistent in depth, and that a further diminution in value will be very gradual. One does not really know the area of this mine yet, but it is considerable, and if payable ore should last down to 1000 ft. it could keep a big mill at work for a number of years.

The Jumbo is not yet a proved mine, but it has the elements of being the biggest mine in the country. It is important that this mine should not be handled in the wrong way. The wrong way would consist in putting up a small mill and crushing the rich ore on the first level, before knowing about the future of the mine in depth. The right way would consist of not putting up any mill till at least 1906, and in the meantime cr. all the money available into development work. The third lev

750 ft., should be opened from end to end, and the fourth level, at 1000 ft., partly driven, before a mill is decided on. If the mine holds its values, a big mill can then be put up—100 or more stamps—and if it does not hold its values, it will then be time to erect a smaller mill. In either case the owners will have to arrange for a considerable sum of cash, either by an issue of shares, or debentures. If they tried to raise such now the capitalists would reply, What have you got to show as security? Your ore-reserves are not blocked out yet, and the ore appears to be getting poorer in depth. On the other hand, if the mine were developed to 1000 ft., and blocked out, showing a big tonnage of payable ore, a debenture issue could be raised, or a share issue made, with no trouble at all, and the fact that at last Rhodesia had a big mine, with very large blocked-out ore-reserves, would be a big advertisement. I have gone thus carefully into the Jumbo's policy because it is one of the three or four new and seeming good mines in whose success Rhodesia will have to rehabilitate herself in the mining world. If any of these three or four things are mishandled it will be a serious matter.

The Plum mine, belonging to the **Mayo** Company, lies two miles from the Jumbo, and carries the same class of lode. A cross-cut put through this at 100 ft. deep showed 150 ft. of ore, and the wall had not been reached. The assay value of the whole cross-cut seemed to average about 14s. a ton. This is quite a wonderful result. Working a formation this width as an open quarry, and using steam shovels, I am not prepared to say that a yield of 10s. a ton would be unpayable. Fuel would be expensive, but there is good water close at hand, and a branch line of the Ayrshire Railway could be run on to the property at a small cost. The further development of this most interesting problem should be watched with interest. We may yet see a second Homestake rising in the Mazoe.

Between the Plum and Jumbo I inspected a small mine called the **Commonwealth**. The country rock here is granite, and the pay-ore consists of a layer of solid granite carrying pyrites. A 5-stamp mill

had been erected, and some development done, at a cost of a very few thousand pounds. The issued capital of the mine is £11,000, and I thought that if all the Rhodesian mines had been capitalized on this basis, and as economically equipped, the country would not have fallen into its present disrepute.

In the Mazoe district are also situated the **Alice**, the **Bernheim**, and the **Kimberley** mines. All these are of the small type.

In the Manica district the only mine of note is the **Penhalonga**, and this I found one of the most interesting mining problems in South Africa. The ore is a quartz, fully eight feet wide. It carries an average per ton of 21s. gold, 5s. silver, 75 per cent lead, and a small amount of copper, and the extraction is 75 per cent of the gold and some of the silver and lead. There are several ore-chutes, aggregating perhaps 1500 feet in length. The mine is worked through a main adit 350 ft. below the highest part of the out-crop. Below this adit a winze was sunk 150 ft., and at this point the ore was found to maintain its width and values. The mine and machinery are worked by water-power, and there are forty stamps. These are to be increased, or subsidiary crushing plant put up, to bring the monthly treatment up to 14,000 tons.

The ore is milled with a plate recovery of some of the gold, and is then concentrated on Wilfley tables. The concentrates carry about £21 gold, £5 silver, 36 per cent lead, and 2 per cent copper. These are shipped to London. Their freight and treatment costs are £7 9s. per ton.¹

¹ COSTS ON PENHALONGA CONCENTRATES, 1904—PER TON OF 2000 LB.

	£	s.	d.
Bags, bagging, and drying	.	1	8 0
Waggon transport to Umtali (eleven miles)	.	1	0 0
Forwarding	.	0	2 8
Rail to Beira (210 miles)	.	1	0 0
Beira pierage	.	0	4 0
Forwarding agent, Beira	.	0	4 6
Brokerage	.	0	5 0
Shipping to London, per 2240 lb.	.	1	0 1
Treatment @ 45s. per 2240 lb.	.	2	
Assays and other charges	.	0	
Total		7	

Penhalonga is essentially a low-grade mine, and has far too high a capital, but it is a good-looking lode; its galena contents is a feature I like, and it seems to have the makings of permanence. Even with a big mill, its profits will be relatively small. The figures for the month previous to my visit showed a recovery of 17s. 9d., and a total cost of 14s. 9d.—profit 3s. per ton; but the average of the mine is considered to be better than this. The mine was being run with thirty-three white men all told. If it were manned with whites in the usual Rhodesian style, it would run at a loss. Drills, for example, are sharpened entirely by natives. The saving on this head is no doubt over £100 a month for a relatively equal efficiency. Altogether the Penhalonga is a well-run mine, and in time should be a profitable venture.

Close by is the **Rezende**. This is an ordinary quartz-mine, and I did not like the appearance of the lower workings. There are twenty stamps here, and the mine has yielded over 100,000 tons of ore; but no profit has yet been earned, and I think it doubtful whether the mine will ever be able to pay off its debt. The directors recently took the sensible action of appointing the Chartered Company's engineer as consulting engineer to the Rezende.

The **Ayrshire** mine I did not visit, but I do not consider it is an undertaking which will be very successful. The capital of the mine is £487,500, and there are £250,000 5½ per cent. debentures. What is there to show for this? There is firstly a narrow-gauge railway, eighty miles long, and secondly there is a sixty-stamp mill and very fine equipment. The mine itself is supposed to be a diorite dyke, with the gold occurring in patches, and at the time of writing the reserves are placed at 200,000 tons, worth 33s. 6d. a ton. The net profit to be earned on this ore is probably less than £100,000, and on such a small reserve the building of a railway and the erection of a big plant was unwarranted. A matter of £500,000 has been spent on this mine, but only a small part of this was put into development. If one quarter of this sum had been put into the

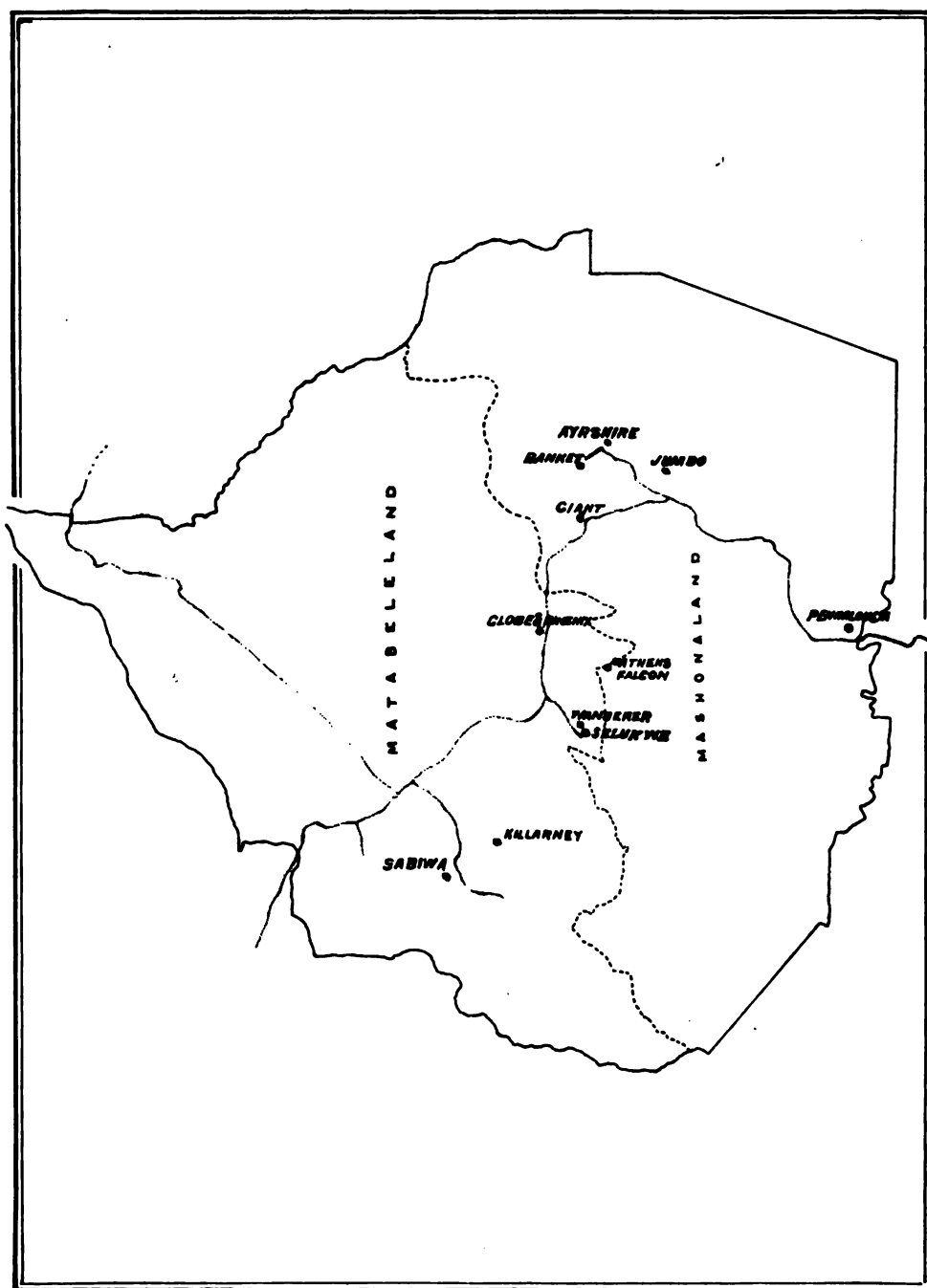
mine, it would have demonstrated the existence, or otherwise, of a large amount of ore, and had the ore been proved there would have been just reason for the spending of the balance of the money. The directors may urge that a borehole went into good ore below any of the present workings, but a borehole does not block out ore-reserves. I look on the past policy of those who control this mine as unsound.

Not far distant from the Ayrshire, on the El Dorado claim, a coarse gold-bearing conglomerate has been found; this is a horn-blende schist, containing fragments of granite, and is in no sense like the banket of the Transvaal. This is thought to continue for a long distance, as there are frequent old workings for miles from here. The El Dorado discovery has been floated as the **Rhodesian Banket**, and in the usual Rhodesian manner has been highly capitalized. Some of this ore is, without doubt, rich, and carries a good deal of visible gold, but whether this is a local patch, or is at all continuous, I cannot at this time pretend to say. This ground is in control of the group which controls the Ayrshire.

Amongst the small mines of Mashonaland are **Golden Valley**, **Inez**, **Battlefields** group, **Lone Star**, **Beatrice**, and **Butterfly**. This last-named mine is one of the De Beers Company's essays in the world of gold-mining. A cash sum of over £70,000 has been sunk in the mine, which when I saw it had got 40,000 tons in sight. I think the maximum profits the mine will yield will be £20,000, or a net loss of £50,000 and interest.

Near the Mashona-Matabeleland border is a big ore-body, owned by the **Falcon** and **Athens** mines. The width I cannot speak to precisely, but it is very great, and much of the ore is above adit level. The ore in the two mines appears to average about 25s. a ton in bulk. The engineer of the Athens, which belongs to the **French South African Development Company**, reported that over a length of 1500 feet there were exposed 525,000 tons, with a recovery value of 20s. a ton; and the Falcon engineer places the value of his mine at not less than this.

It has to be noted that there is some copper in the ore of these



**MAP OF RHODESIA—SHOWING THE MOST PROMISING GOLD MINES.
AND THE RAILWAYS.**

two mines, running up in place to as much as 2 per cent. It seems to me that this will be a serious drawback when it comes to cyaniding, especially on a low-grade ore, where a high extraction is essential. If this metallurgical drawback can be settled, I would look on these two mines as attractive problems, amongst the best in Rhodesia.

The last mine to be referred to in Mashonaland is the **Giant**, in the Hartley district. In a sense it is a better-looking mine than the Jumbo, for although not of the same dimensions its values are more consistent, and at 500 ft., the present lowest point reached, they show no falling-off. The ore-body is 500 ft. long, and not less than 12 ft. wide. It is a free-milling ore, and will assay, in bulk, round about 50s. per ton. The lode is schist, and lenticular, or rather a series of lenses making one on the other, and in this respect is similar to the Sons of Gwalia mine in West Australia. The mine at 500 ft. looked well, with a lot of mineral coming in. It is just possible that in the west a new ore-chute will be found to make, in which case the area of the mine would be enlarged.

This is one of the three or four mines on which the future of Rhodesia very much depends, and as in the case of the Jumbo, I hope that those who control it will make no mistakes in policy. I believe the Giant will be all right in depth, but I would develop another two levels yet to make quite sure, and only after that would I decide on any mill. When, at some date in 1906 or 1907, the directors of the Giant can say, "We have here a mine with as much net profit in sight as the mine is capitalized at in the market," they will get all the money they want for equipment. There has never been a mine in Rhodesia yet with ore-reserves at all commensurate with its market valuation, but the public is being educated in this respect, and will have nothing to say to Rhodesia until such security is offered them. This is worth the consideration of those who control the Giant. In the Hartley district there are several biggish deposits of ferruginous schist, carrying gold, which may in time be proved to be payable. Among these are the Concession Hill, Mombe and Goth claims. These are as yet in the prospect stage.

In Matabeleland there are not so many promising mines coming forward, and the older producing mines are working with small success. A hopeful mine, of, however, the small type, is the **Killarney-Hibernia**, which is said to have a fair amount of profit in sight. The Killarney reef is narrow, but with pay-chutes aggregating 1500 ft. long, while the Hibernia is shorter and richer. The mine is excellently equipped, and by the use of stamps and a tubemill a direct recovery of 90 per cent is hoped for.

On my last visit to Rhodesia I formed the opinion that the Jumbo and Giant were the most hopeful of the newer mines, and that the future of Rhodesia, and its good name in the mining world, depended much more on the fate of these mines, and on the way they were handled, than the people out there had any idea of.

The Gwanda district, once looked on as the hope of Matabeleland, has turned out most disappointing. The **Geelong** is in debt and shut down. The "Geelong" reef itself has no doubt gone wrong, but it is possible that the "Valley" reef might be made into something. The **West Nicholson** is also shut down. Some day this big ore-body might be worked at a profit, but I'm afraid this is doubtful. The small "ten-stamp" mines of the district are the **Jessie, Eagle-Vulture, Anterior, Imani, and Dumbleton**. The latter is noteworthy as having one of the smallest capitals of the Rhodesian "ten-stamp" mines, and is the only mine of all this series which has paid a dividend.

The interesting mine of this district is the **Sabiwa**. It has a big low-grade ore-body, and a reserve of 180,000 tons of 30s. ore. A time came in the history of the Sabiwa when it had most of its machinery on the ground, and no cash to erect it; but I believe there is enough profit in sight to pay for the completion of the plant, and there is just a chance that the mine has the elements of permanency. It is, at least, like the others, Falcon, Athens, Penhalonga, and Plum, one of the interesting low-grade problems of the future.

A batch of small ten-stamp mines in Matabeleland may be dismissed with the mention of their names : **Dunraven, Matabele Sheba, Red and White Rose, Rose of Sharon, Moonie Creek, Guinea Fowl, Veracity, Gaika, Queen's, Morven, Nelly and Pioneer, Sabi, Gatling Hill, Confidence, Belingwe, and Theta.** The last of these is perhaps the best ; but instead of the capital of £80,000, for which it was lately floated, a capital of £25,000 would have been the right figure. Those in control of this mine have had experience floating small mines which have turned out failures. Why has it not taught them something ?

The **Surprise**, in the Selukwe district, gives some hope of becoming a profitable mine.

The **Bonsor** and **North Bonsor**, if their values had continued, had the makings of a bigger class of mine ; but they did not continue, and these mines are now being worked on tribute.

The **Selukwe Columbia**, close to these, has some ore developed, but its value in depth has not yet been determined.

Another mine in the same district is the **Wanderer**. Here you have an immense ironstone body of refractory ore which is being treated by dry crushing. The costs are low—nor more I suppose than 10s. or 12s. all told ; but the yield is also low, and before profits can be paid away a big debt has to be cancelled. The ore-reserves are placed at 400,000 tons ; but it is not certain that all this is of equal value to the ore already treated : while the costs, as the workings reach below the surface level, will tend to increase.

There remain to note only the **Globe and Phoenix** and **Selukwe**, Rhodesia's best mines up to date. The first of these is now within measurable distance of paying back the cash sunk in it, but the Selukwe has not nearly reached that stage yet. The **Globe and Phoenix** has at the present time about two years' ore-reserves. Several of its levels have been very poor, and although better ore is now being met with in the bottom level at 1200 ft., I cannot speak with certainty of the future. The profit in sight, with the shares at £1 12s. 6d. was, at the date of last report equal to 25 per cent

of the market valuation. Selukwe's ore-reserve is probably smaller, and though this mine too is in good ore at the bottom, yet the chute is neither so long nor so regular as it used to be. The profit in sight, with the shares at 17s. 6d., was 17 per cent at date of last report. The reserves of these mines are infinitesimal in relation to their market value.

Outside Matabeleland, in the **Tati Concessions**, there are gold reefs, and that of the **Premier** is of big width. So far Tati has done no good, but it is not fair to write the mines off as of no value. They are worth the consideration of capitalists for further development, before being definitely condemned.

It looks at present, from data taken from the known mines, that Rhodesia should reach a gold production in 1906 or 1907 of not less than £2,000,000 for the year; but it is not yet certain that this figure can be maintained. The average yield per ton in 1903 was 33s.; it should not be materially lower than this in 1906-7.

The future of the country depends in my opinion mainly on the big, and mostly low-grade, ore-bodies. The best of these look to be the Giant, Jumbo, Penhalonga, Falcon, Athens, and Sabiwa, and the best of the narrow reefs may be Killarney-Hibernia. The conglomerate discovery may turn out a good thing, but I can venture no opinion about this yet. The group is completed by the inclusion of more doubtful mines, such as Plum, Selukwe, Globe and Phoenix, Ayrshire, Surprise, Wanderer, and Theta, subject to their limitations already referred to.

The future policy for the Rhodesians, if I may advise them, should be "No more small mines," and put money into ore-reserves rather than into premature equipment.

CHAPTER IX

THE GOLD-MINES OF WEST AUSTRALIA

THE gold output of West Australia in 1904—£8,129,000—shows a falling-off from the figure of 1903; while 1905 will show a still smaller figure. This is a true reflection of the prospects of the mining industry there, which are much changed from what they were two years ago, and are at present not satisfactory.

The serious outlook for the future is not apparent to a superficial observer. The dozen or so famous mines of the country continue to produce largely; as they are, in the aggregate, amongst the best-managed mines in the world, their working costs are continually being lowered, while the completion of the Government water scheme has further assisted in the same direction. These facts—the big outputs, the good management, the falling costs, the supply of fresh water—together with the substantial dividends, are now realized by many. What is not generally realized is that these older mines contribute the bulk of the country's output; that they have already passed their zenith and will produce less each year; and that hardly any new mines are coming forward to take their place and counterbalance their gradual falling away.

In the earlier days, besides the English-owned companies, there were hundreds of small mines worked in West Australia, either by their original discoverers or by small parties of miners. These at one time contributed the larger part of the output, and this method of prospecting led to the discovery of some of the present big mines. These small, rich patches, so far as the better-known districts are concerned, are now mostly exhausted. The bigger

mines which have survived them are becoming poorer with depth, and have already mostly passed their periods of maximum production. As things look at present, the next year or two will show so heavy a drop in the output that the Government will be forced to take action. I should be glad if I could convince it that to take action at once is the better course.

To West Australia, at least for many years to come, the gold-mining industry is everything. Some day the undoubted pastoral and agricultural value of that country will cause it to make great strides; but in the meantime, in order to pay its way and redeem its big debt, it is the gold of the great inland desert which is relied on. Had the whole of the vast gold-field been already explored, and only the present mines exposed, the outlook would be serious indeed. But this is not the case. Much of the country has never been properly prospected; some of it not at all. This country is waterless. The prospector or fossicker cannot stand the cost of ensuring himself a water supply in these far-out parts, and the once great influx from Britain of money for all sorts of prospecting purposes has now completely ceased. The alternative seems to me obvious. The West Australian Government should undertake to have the whole of the interior prospected; and it should arrange, either by boring for water, digging wells, or by building tanks or storages and keeping these supplied, to cover, even if temporarily, every likely district. A corps of 400 or 500 prospectors, each financed to the moderate extent of his usual requirements, and leavened by a few explorers of superior mining knowledge, would complete the experiment. Then as to the older and easily accessible districts, the Government should subject these to careful re-examination at the hands of experienced mine-valuers. It is possible that there are still in these districts many patches of ore, or even potential mines of some magnitude, which under present conditions would pay to work. For the sake of what gold-mining means to West Australia these sources of supply must not be overlooked.

This scheme may at the first glance seem unpractical; but I

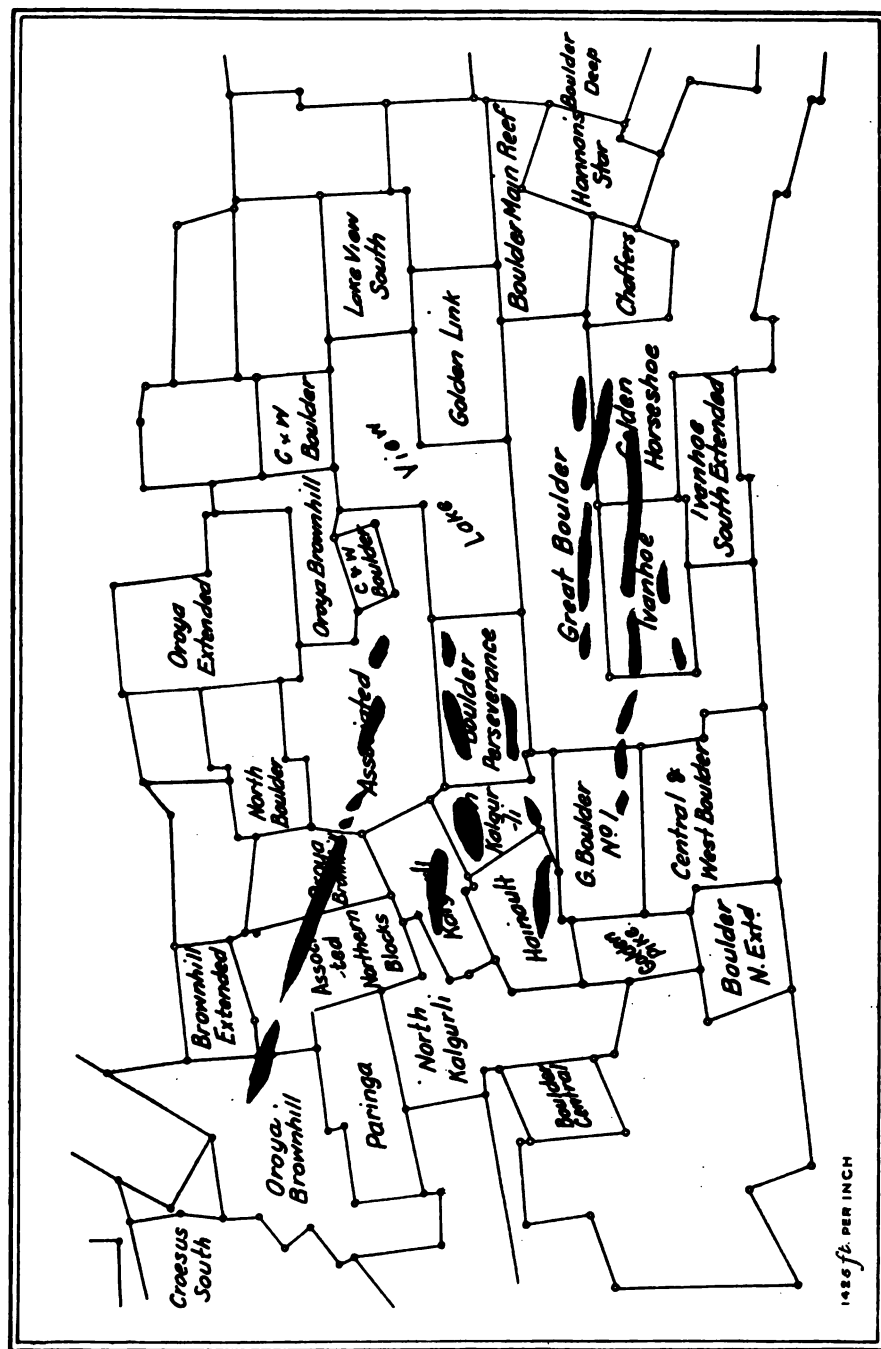
venture to think that it is not really so. It cannot be urged that this is not the work for a Government, for, as I have said, the prosperity and solvency of the State depends at present on gold-mining. It is clear that the whole gold-field has got to be prospected. But it is a fact that there is no prospecting in the waterless districts, that there is very little prospecting being done even in the older districts, and that no capital is now available for this. Surely the alternative is that the Government should take up the matter. It has already done good service by erecting crushing mills at various places, to which the individual miner or prospector could cart his ore. A scheme for financing the prospector, and supplying him with water, in return for his exploration of the desert, besides being the only way to develop the country's chief asset, might be no bad investment in the long run. The inference is, of course, that the waterless parts of the gold-field contain many potential mines of more or less permanence; that by their discovery the gold yield can thus be maintained for a number of years, and that the Government, although not actually owning these new mines, would, by their help, draw enough revenue to redeem a large part of its present debt.

Take, as an example of debt to be redeemed, the sum laid out on the Coolgardie-Kalgoorlie water scheme—amounting to more than £3,000,000. As now worked, this undertaking is earning a bare interest on the loan, but no sinking fund. So far as can be seen the redemption of this loan will have to be provided out of general revenue. It is incumbent on the Government that this should be done during the lifetime of the Kalgoorlie field. That field, however, has passed its highest output, and it is improbable that it will in future produce surplus revenue to the extent required for this purpose. It looks, therefore, as if, on the top of a falling revenue, the Government will ere long be called on to make big yearly provision for repayment of this loan. To avoid financial embarrassment, its greatest hope is in the meantime to open up new mining districts, and I believe myself right in advising that this should be done at once.

I may be speaking to deaf ears. A Labour Government is in power at present, subject to the somewhat capricious vote of the working man. He, on his part, so far from taking note of the falling output of gold and the serious condition of most of the bigger mines in their lower workings, is devising schemes which will ensure him shorter hours, bigger wages, and still more weight in the economic scale. If he only knew it, this is not the time for antagonizing capital. Unless his Government is encouraged in drastic financial steps, the country may before long come upon hard times. He, as miner, may find the mine he has worked in exhausted, and shut down, and his occupation gone. With the State in financial straits, and capital disgusted and driven off, he will be in a bad way indeed.

Setting to one side the unprospected country, which may or may not yield up riches, it must be said that at present the outlook is bad, and that nearly all the future depends on the fortunes of a dozen mines. This gold-field has failed to come up to expectations. There have been at one time or another at least fifty mines giving hopes of permanence—to say nothing of the hundreds of small reefs or short ore-chutes—but gradually these have gone wrong in depth.

Curiously enough, while so many mines were failing, the management of those which survived was becoming ever better. As I have already said, the big West Australian mines are in the aggregate as capably managed now as any in the world. This capable management has held before it one cardinal policy—the building up of big ore-reserves; and it is on the security of this asset in the leading mines that the whole fabric of the industry is based to-day. The valuation of any quartz-mine, as I so often state in this book, ought to be based on one fact—the relation of the profit in sight to market valuation—and on this basis, thanks to the sound policy of the respective managers, the leading West Australian mines stand in a relatively good position.



KALGOORLIE FIELD—SHOWING THE BEST REMAINING ORE-BODIES.

The Kalgoorlie gold-field, discovered in 1893, reached its high-water mark of production in 1903; and so far as can be seen at present, there will be a gradual falling off in the output each year after. If the condition of the mines at Kalgoorlie is analyzed, it will be seen that, almost without exception, they are becoming poorer with depth, while already a number of the smaller mines have become unpayable.

Amongst the big mines Lake View, Boulder Perseverance, and Associated Northern Blocks have greatly deteriorated in depth, and are probably drawing near the time when profits will fall off seriously or cease altogether.

As regards other big mines—Kalgurli, Oroya-Brownhill, Ivanhoe, Great Boulder, and Golden Horseshoe—the results at the lowest points reached are not so serious. On the average they show a gradual, distinct impoverishment, but the lowest points still show ore of good payable value. In addition, the position of these five mines is strengthened by their large ore-reserves.

Coming to the smaller mines of the field, it is found that the prospects of nearly all of these are hopeless. With the exception of Hainault, South Kalgurli, Boulder No. 1, Central and West Boulder, and Ivanhoe South Extended, which for one reason or another have some speculative value, I could not fix on one other mine as being likely to ever return the money sunk in it. Such mines, therefore, as Boulder Main Reef, Hannan's Star, Boulder Deep, Lake View South, Chaffers, Golden Link, North Boulder, Brownhill Extended, North Kalgurli, and Paringa, must, I am afraid, be written off as of little or no commercial value. In several of these small mines there is some low-grade ore which might pay if treated in the plants of one or other of the bigger mines, but the price which the bigger mines could afford to pay for such ore would be small.

It is not to be assumed, because all the mines have either become poorer or actually unpayable, that Kalgoorlie as a gold-field is going to be worked out in a very few years. The rich ore, even in the best mines, will, I think, be exhausted before 1910, and the dividends

after that date will be on a much smaller scale than at present. Many of the present producing mines, too, will be shut down by that time. But there is a great deal of low-grade ore on this field, and the big plants, with their excellent organization and equipment, will probably continue to work for years after the richer ore is gone, apportioning among themselves all the low-grade ore of the field.

The impoverishment of the Kalgoorlie mines in depth has been to a large extent balanced over the last four years by the steady lowering of working costs. A time is coming, however, when the minimum figure in costs will be reached, and when that figure is reached the profits will begin to fall off. So far as I know, the only mine on the field which has not yet shown a notable falling-off in depth is the Kalgurli, which in the lowest workings at 1050 ft. yields ore of average value. As against this, the ore in the lowest level of all the other mines on the field shows more or less deterioration from the average. Referring to such mines as Great Boulder, Ivanhoe, or Golden Horseshoe, one cannot pretend to estimate the precise depths at which they will become unpayable, but the fact of gradual impoverishment seems to be clearly established.

The western series of lodes at Kalgoorlie, beginning in Boulder Deep, runs through Hannan's Star, Boulder Main Reef, Golden Horseshoe, Ivanhoe, Great Boulder, and Boulder No. 1. So far as is now known, these lodes, although not resisting the usual tendency to impoverishment, carry payable values to greater depths than other lodes on this gold-field. It will be found that Great Boulder, Ivanhoe, and Horseshoe will work more payable ore below 1200 ft. than all the other mines put together.

The two mines at the southern end of this zone—**Boulder Deep** and **Hannan's Star**—are probably of small value. In each there is some low-grade ore; but if the controllers of these mines carry out a policy of working each as a separate unit, with a small and necessarily expensive plant, it seems improbable that either will earn

real profit. A sale of these two small properties, on a royalty basis, to one of the bigger organizations—say to Ivanhoe or to Lake View—where large plants are already installed, might result in the ore being mined and treated at a small profit. This is, economically, the right way of disposing of the small mine all over the world; but there is an element of altruism in it often not palatable to its directors.

Boulder Main Reef has been a fairly good mine, but is now apparently almost worked out. In the adjoining area, belonging to the **Chaffer's** Company, no ore has been found.

Golden Horseshoe. At the end of 1904 the ore-reserves were stated to be 954,000 tons, of a value of 75s. 8d. The net profit on this ought to be about 32s. 6d. a ton, or, say, £1,550,000. With the shares standing at £8, the market valuation of the mine is £2,400,000, and the proportion of profit in sight 64 per cent. This would be just about a correct valuation, if the mine continued to show ore of average value in depth. But it does not; the values below 1000 ft., although still fair, do not at all come up to the average of the blocked-out reserves. The mine may last for many years yet; but it is turning into a low-grade mine, and the shares, when they truly reflect this change, will not stand at £8.

Ivanhoe. This company, taking note of mine, equipment, and management, is to my mind the soundest organization at Kalgoorlie, and will probably be in a position to outlast most or all of the others. In time to come, because of these advantages, it should have a lien upon the smaller mines, or upon yet unworked deposits of low-grade ore; and after its own ore is exhausted may, in this manner, earn small profits for an indefinite period. As a mine it is not necessarily a better property than Golden Horseshoe or Great Boulder; but compared to the former its output has not been forced, while compared with the latter its pay-chutes carry a far larger tonnage of ore.

On the ore-reserves as shown in the last report there is a net profit, including cash in hand, of about £1,170,000. With the shares

at £8 7s. 6d. this is equal to 70 per cent of market valuation. As in the case of Golden Horseshoe, the lower levels are exposing ore of less value than the blocked-out reserves, and the future of the mine will be on a relatively low-grade basis.

The Ivanhoe is now developed to 1200 ft. Not many yards distant is the shaft of the Great Boulder, which has exposed payable ore on one of the parallel reefs of the series at 1900 ft. Arguing by analogy, one would expect that the Ivanhoe lodes would also be payable to this depth, in which case the life of the mine would be a long one. If the evidence of the Ivanhoe South Extended borehole is taken into account this view is strengthened. Against such assumption is the evidence of the horizontal bore, which was started from the 1600-ft. level of the Great Boulder and went right through the Ivanhoe ground. Only one small reef, and that of moderate value, was met with. On the whole the evidence goes to show that Ivanhoe will have a fairly long life on its own ore; but the present profits per ton are not likely to be maintained, and the shares, at over £8 are fully valued.

Ivanhoe South Extended, assuming that the Ivanhoe lodes dip into its area, is the deep level of that mine. A borehole was sunk close to the joint boundary, and at 1950 ft. a reef was cut several feet wide. The value was reported as being exceptionally high. There is naturally doubt as to whether this result represents the actual value of the reef over any large area. The inference is that at this depth the ore at Kalgoorlie is not rich; however, judgment may be deferred until a shaft reaches the spot.

Great Boulder. Like Golden Horseshoe and Ivanhoe, this mine has found poorer ore in its lowest levels, and before long the profit per ton will fall off materially. It is also stated, as an unsatisfactory feature, that the rock in the bottom of the mine at 1900 ft. is changing its nature, and that calcite is showing freely. There is some good ore at that depth, but the lower levels on the whole show a falling-off.

As against this, one has to note blocked-out ore-reserves, showing,

together with cash, etc., a profit of £1,145,000. equal, with the shares at 22s., to 60 per cent of market valuation. It is also certain that by the time all the levels down to 1900 ft. have been fully extended a great deal more ore will be available.

A strong point, in reserve, about this mine is the north end of the property. From the result of boreholes there is good reason to think that a considerable area of new ground will be opened up here. This ore is expected to be free milling, and though apparently of only moderate value the profits from this source should be material.

The value of the shares hinges, not upon current profits, but upon the appearance of the lowest workings.

Boulder No. 1 carries the extension of the free milling ore-body located in the north end of Great Boulder. It is quite possible that a portion of this inside the Boulder No. 1 is payable. An amalgamation of this mine with Great Boulder is undoubtedly the right economic policy.

The middle series of reefs on the Kalgoorlie field runs through Lake View South, Lake View, Golden Link, Boulder Perseverance, South Kalgurli, and Hainault. These lodes have not withstood the test of depth, and the two principal mines along this line are now approaching their end.

Lake View South and **Golden Link** are shut down.

Lake View at the time of writing this, is working from hand to mouth. This mine has been worked to 1800 ft., but no material profit has been earned from ore below about 800 ft. There are large deposits of very low-grade ore exposed; but it is doubtful whether even such a finely designed plant as the *Ivanhoe*, will one day—say eight years hence—be able to work these at a profit. There is just a chance that the extension of the Oroya chute in depth may be found in this mine. Lake View has a considerable cash reserve, and will no doubt acquire interests elsewhere.

Boulder Perseverance went wrong below 700 ft., and up to the

time of writing this, the payable ore exposed in the levels below that has been insignificant. I think the inference is that by the end of 1907 the mine will be on a low-grade basis.

South Kalgurli and **Hainault** are small mines, although the latter, with its smaller capital, is probably the better of the two. Each, working separately, will earn some profit for a year or two, but the ore-bodies are not extensive enough to set great reliance upon a more remote future. These two mines should be amalgamated.

The east series of lodes comprises Central and West Boulder, Associated, North Boulder, Kalgurli, North Kalgurli, Paringa, Associated Northern Blocks, Oroya Brownhill, and Brownhill Extended.

The **Central and West Boulder** is a small area, which still retains some interest among the living mines because of a borehole. This was sunk some years ago, and at 1300 feet is supposed to have cut a valuable ore-body. This hole has been surveyed, and it is shown to have deflected so much that the rich ore-body, if it exists, is inside the area of the southern block of the Oroya Brownhill. The weight of evidence, however, hardly points to rich ore at this spot, and it is to be feared that this result may not be verified.

Associated. This is another mine which has not stood the test of depth. The ore here is found in bunches, and the discovery of these has kept the mine going for several years after the better-defined ore-chutes gave out. The present evidence is that current development is not keeping steps with treatment, and that the blocked-out reserves are gradually falling. On 31 March, 1905, the reserves are given at 109,000 tons, or, say, a year's supply. I do not suppose the mine will yet come to an end, for it seems likely to carry on in a hand-to-mouth way for some years. There is, too, of course, a chance of the Oroya chute, now traced into the Associated, turning out a good deal of rich ore; the dimensions and value of this ore-body in Associated have so far been disappointing, but there is still prospective value under this



SURFACE PLANT, SONS OF GWALIA MINE

The company has a substantial reserve of cash ; but on present ore-reserves the shares have no great value.

North Boulder, Paringa, and North Kalgurli, are small mines, and not, so far as I know, of commercial value. The latter is producing at present.

Kalgurli. The blocked-out reserves, by the last report, figure at 365,000 tons, and the net profit at £670,000. With the shares at £7 6s., this is equal to 76 per cent of market valuation. This figure is conservative ; for the ore-bodies, especially on the 200-foot level, have proved of bigger dimensions when stoped than had been estimated. This is the only Kalgoorlie mine which has not become poorer in its lowest levels, for so far as can be seen the values at 1050 feet are not materially lower than those of the whole of the blocked-out reserves. But this depth, or a little lower, has been so fatal to most of the mines on the field, especially to those on the middle and east zones, that the shareholders in Kalgurli must be prepared at any time for impoverishment to set in. The present condition of the mine is very sound.

Associated Northern Blocks. This is one of the mines which has gone wrong in depth, but has carried on for several years longer than expected by discoveries of bunches of good ore. It seems unlikely that the mine will continue of much value beyond the end of 1906. There is a substantial cash reserve.

Oroya Brownhill, at the time of writing (April, 1905), is, in the sense of security, the best of the Kalgoorlie mines, for whereas the market valuation of the mine, at £3 5s. a share, is £1,462,500, it is certain that the profit in sight, together with cash in hand, amounts to rather more than this.

Until, say, the end of 1907, the profits from this mine will be very great. But there is only a definite quantity of rich ore, for the chute runs obliquely across the property, not down into it, and when this is exhausted, the mine, as far as profits are concerned, will be of probably small value. There may be a year or two's

work afterwards on low-grade ore yielding small profits ; but the present shareholder must see to it to redeem his capital while the rich ore is being taken out.

There remains to note the south block of this mine, containing the supposed rich discovery due to the deflected borehole put down by the Central and West Boulder. I imagine, however, that this block does not carry payable ore to a great depth, and that beyond a certain amount of low-grade ore already exposed, it will not yield much.

The value of these shares depends almost entirely on the already blocked-out ore-reserves, and should fall steadily as each dividend is paid away. With the large reserve fund a new mine will be bought, should opportunity offer.

Brownhill Extended. A small piece of the rich Oroya chute passed through one corner of this property. This has been worked out. It is hardly probable that any more ore of much value will be located.

On the Kanowna gold-field, about thirteen miles from Kalgoorlie, are the **White Feather**, **White Feather Main Reef**, and **Robinson**. These are small mines of doubtful future. The **Queen Margaret** mine at Bulong is shut down. The **Red Hill** still produces.

The Coolgardie field still yields some gold, but there is no mine in the district could be named as being in a sound condition. The most consistent mine has been **Burbank's Birthday**, but this is thought now to have gone seriously wrong in depth.

Bayley's United still produces a little, but such mines as London-derry, Lady Loch, Vale of Coolgardie, and Sherlaw's are now shut down.

Westralia and East Extension, a flat quartz-reef lying in granite, is the largest producer near Coolgardie at present.

The **Hampton Plains** properties have not yet earned any profit.

The Norseman field is mainly concerned with the fortunes of the **Princess Royal** mine, an Adelaide-owned company, which still earns profits. The other mines of the field are mostly shut down, or worked by tributors.

The Southern Cross field is another of the failures. So late as two years ago a big lense of ore was found in **Fraser's South Extended**, but this apparently was of poor value.

One of the now small number of mines at work between Kalgoorlie and the northern districts is the **Golden Pole**. This is one of the few newer mines of the country. It is a small, rich lode, and has, I believe, been proved to 400 ft. While it lasts it will no doubt be very profitable; but a mine of such dimensions is liable to go wrong in depth at any time, and to capitalize such a property at much more than the value of the profit in the exposed ore-reserves is not sound.

The Menzies field has not survived the test of depth. Some of the mines still produce a little gold, but no profits are being earned. Amongst the mines here are **Lady Shenton, Florence, Menzies Alpha, Queensland Menzies, and Menzies Consolidated**.

The large section of the West Australian gold-field lying between Menzies and Cue at one time gave evidence of carrying a number of permanent mines; but one after another these have gone wrong in depth, until there are at present not more than four or five to which this title is applicable.

The **Cosmopolitan**, while it lasted, was a good property, but below the 8th level the ore-chute began to contract, and at the 10th level it had quite died out. I do not think this mine can last much longer. There is a reserve fund of close on £100,000, and the company will no doubt secure a mine elsewhere. The surface equipment can probably be sold to the Lancefield mine for a good price.

The **Cumberland Niagara**, adjoining, worked a small corner of the Cosmopolitan ore-chute, but has not, I think, any other ore-chute in its area.

Westralia Mount Morgans has become poor in depth. The extension of its ore-bodies is found in the **Millionaire**, but at this point they are of small value.

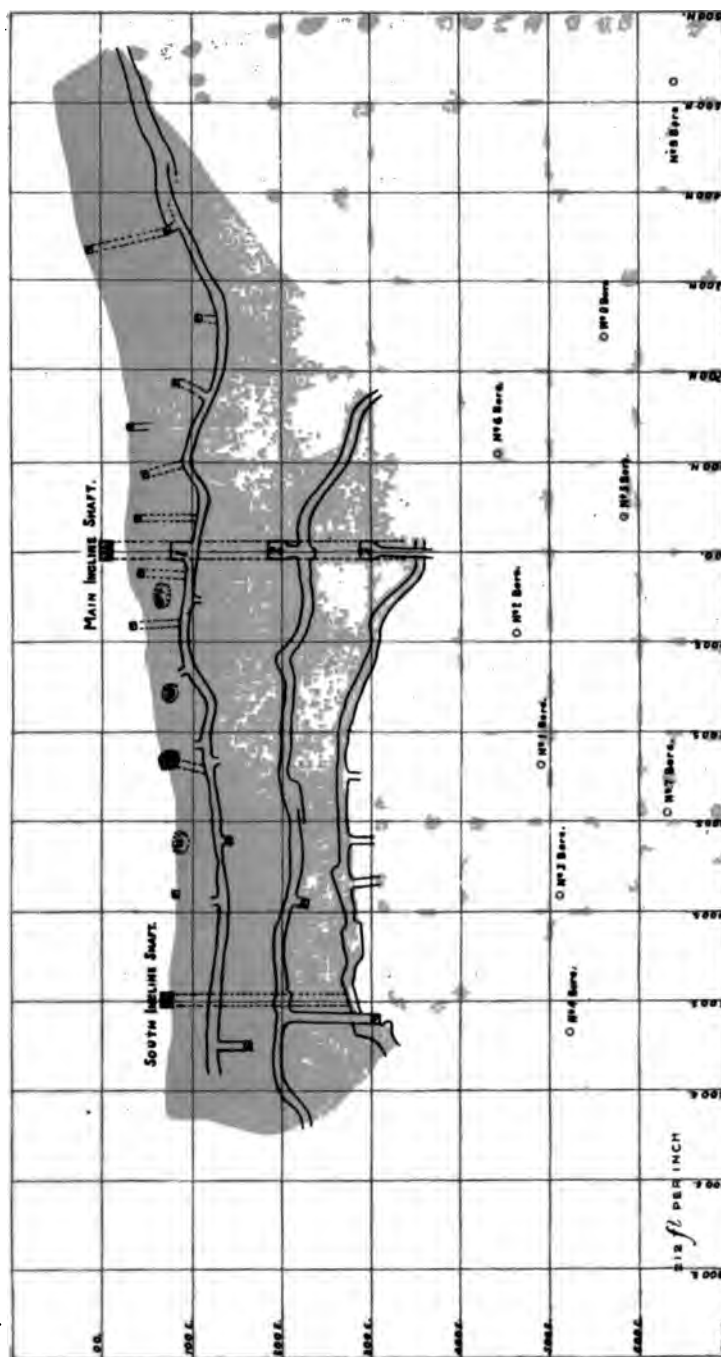
Merton's Reward may produce for some time longer, but is a small mine.

In the Laverton district the **Euro** and **Craiggiemore** have failed to carry value in depth. The **Ida H.** has earned profits, but its future is hardly on an assured basis.

The **Lancefield** seems to be the best mine discovered in the country since the Great Fingall. In a sense it is not new, for it was worked for a long time by a small syndicate, but in its present state, with a fine equipment and good management, will yield results altogether different. Here is an ore-chute over 1200 ft. long and about 12 ft. wide. On such dimensions as these—say 120,000 tons to the 100 ft. in depth—it is possible to run at least 100 stamps, and no doubt that will be the eventual number worked. At the time of writing this ore-body is developed to the third level, and below this again a series of eight boreholes cut the ore between the horizon of the fifth and sixth levels. The evidence of the actual work on the third level, and the row of bores below, goes to show that there is no falling off either in value or size and the ore thus exposed—one-half of which is blocked-out—is about 600,000 tons.

Here, so far as can be seen, are the elements of permanence, and for some time to come the company will, no doubt, apply its profits to increasing the mine's capacity. There are now fifty stamps, but it is probable that a hundred at least will be needed.

The **Lancefield** is a low-grade mine. I do not expect the yield to exceed 28s. a ton. A few years ago this would have been unpayable. To-day, thanks to the finest organization and management, such a yield should give nearly 10s. a ton net profit. Latterly the **Cosmopolitan** mine, under the same management, has been worked for 18s. a ton, all told. **Lancefield** will be a cheaper mine to work; but even at 18s. the profit should be nearly 10s. a ton,



LANCERFIELD MINE—SHOWING ORE BLOCKED OUT & EXPOSED BY BOREHOLES.



and the total profit in sight is more than the present market valuation of the mine. There are facilities for cheap working—plenty of fresh water, abundant fuel, a railway, a big lode, and a fine equipment. The ore is reported to carry arsenic in the sulphide rock, and at present the extraction is poor. This should be improved on gradually, and I expect eventually to see an extraction of about 28s. a ton.

Out beyond Laverton is the Earlstoun district—a field of small patches, so far as yet known. Owing to lack of water, prospecting has not penetrated much beyond here.

In the Leonora district are a number of mines with some good ore. Several of these may arrive at the stage of individual production—the **Great Tower Hill**, for example—but, economically, their best fate is absorption into the **Sons of Gwalia** and treatment of their ore by its splendid plant. The lenticular ore-bodies in this mine have been persistent, and may continue to a great depth. As to value, this has been all right to the twelfth level. The thirteenth level, the present bottom of the mine, is poor ; but there have been poor spots before, and I do not assume that as yet any definite impoverishment has set in. The blocked-out ore above this, measured conservatively, showed at last report 365,000 tons, with a net profit of £480,000. With the shares at £2, and including cash in hand, this is equal to 77 per cent of market valuation.

The plant and leases of the old East Murchison United mine at Lawlers may be bought by the **Vivien**, located nine miles distant, and one of the few new mines of the country. This mine has an ore-chute 900 ft. long and 5 ft. wide, proved so far to the third level. The last report showed over 50,000 tons blocked out, having a net profit of £1 a ton. The purchase of the fine plant of the East Murchison for a small sum would materially assist the Vivien, which may in time become a sound mine.

The **Bellevue Consolidated** is still in the doubtful stage. The old tailings are a valuable asset. The mine itself is too spotty in values in the lower levels to please me.

The mines at **Lake Way** have been failures.

Between Lawlers and the Murchison lies the Black Range field, with a number of small deposits. So far as I know, no large mine has shown itself here.

The Murchison field is disappointing. Amongst the discovered mines there seems to be nothing solid but Great Fingall. I cannot, however, believe that this field has been properly prospected, and would recommend the district to the Government, as specially worthy of detailed exploration.

Great Fingall, in the last report, shows a profit in sight of £1,700,000. With the shares at £7 17s. 6d., this is equal to 89 per cent of market valuation. The eleventh level, the lowest in the mine, has been quite disappointing. This does not necessarily mean more than a local deterioration, for only part of the level showed a falling-off; but until the twelfth level has been driven, and proved good, the shares must be considered as being fully valued.

The small mines in this neighbourhood—**Murchison Associated**, **East Fingall**, and Kinsella (belonging to **Cue Consolidated**)—are no good.

At **Peak Hill** the mines are disappointments.

In the Far Northern districts I know of no payable mines.

From the foregoing list of West Australian mines, I select as the soundest: Lancefield, Oroya Brownhill, Ivanhoe, Sons of Gwalia, Kalgurli, Great Boulder, Golden Horseshoe, and Great

CHAPTER X

THE GOLD-MINES OF EASTERN AUSTRALIA, TASMANIA, NEW ZEALAND, AND NEW GUINEA

IN the chapter dealing with West Australia it has been shown that, unless there are new finds there, the output of gold will decrease materially. The same condition of things exists in Queensland, and, I believe, in New Zealand. In New South Wales, too, the tendency is rather downward than upward. Tasmania and South Australia do not produce much gold.

On balance, so far as I can see, the Australasian output of gold, which in 1904 was £17,928,000, will fall away for some years to come. In the immediate future this will be mainly due to decreases in West Australia and Queensland.

It is often said that the socialistic tendencies of the Australasian States are driving capital away. So far as mining is concerned, this assumption is hardly correct as yet. There is capital available in London for all the mines Australasia can sell, provided they are offered at a reasonable price. The trouble is that few mines of any value are now being found.

On the other hand, it is true that the labour vote is gaining strength each year, both in Australia and New Zealand. There has already been a federal labour ministry, and the labour party in the federal parliament is powerful. In West Australia the present government is a labour ministry, while in South Australia and Queensland the labour party appears to hold the balance. New Zealand is notably socialistic.

Up to the present, legislation and the arbitration courts may have

often tended to favour the miner as against the mine-owner ; but I do not consider that the position of the latter has been harmed in any essential. The fear is that, as the pendulum swings still further, one or other of the labour governments will abuse its power. In this case capital would certainly take alarm ; but until such a case arises, the acts of the labour parties should be judged with an impartial mind.

Of these two factors—a falling output of gold, due to the exhaustion of old mines, and the lack of new discoveries ; and the increase of socialistic legislation against the mine-owner—I reckon the first to be the more serious where the future of Australasia is concerned.

Victoria. Next to California, which country it may be said to rival in almost ideal facilities for mining, Victoria has produced more gold than any other part of the world. Since the first discoveries in 1851, the official figures show a yield of over £275,000,000 sterling ; in addition to this a large amount is estimated to have been taken away by the earlier diggers, principally by Chinese, who left no records of their work. The yearly output has never fallen below £2,250,000, and is now about £3,250,000.

The gold-mines of the state pay about £500,000 a year in dividends ; nearly all of this going to the local owners, and the importance of the industry to the country, both directly and indirectly, is material.

Nearly all over Victoria gold is found in greater or less quantity. Many of the reefs have been worked out long ago ; but each year new reefs are being found which, even if unprofitable on balance, add to the general output. Victoria will continue to yield more or less gold for generations to come.

The principal mining district in the state is the wide mineral belt which has centres so far apart as Ararat, Ballarat, Maryborough, Castlemaine, and Bendigo. In the north is a belt running through

Beechworth and Rutherglen; and the Gippsland district in the east, though only partially prospected, carries gold throughout. Here and there in other parts of the country gold is worked, but not to any great extent.

In all these deposits there is considerable variety. A white low-grade quartz, carrying free gold, is commonly found; but in Gippsland and elsewhere the ore is refractory and base, and often of high value. In other districts the alluvial deep leads are worked, and river-dredging and hydraulic sluicing have of late years been carried on in a number of places.

There are no big gold-mines in Victoria. No individual venture produces regularly as much as £10,000 a month, and only a few produce £2000. But there are hundreds of small concerns with intermittent yields, and to them the larger part of the output is due.

British capital is sunk to only a small extent in Victorian quartz-mines. This is as it should be, for the majority of these are too small to stand the cost of consulting engineers, management, directors, London offices, and the heavy capitalization with which they would inevitably be burdened. A mine running ten or twenty stamps on low-grade ore may, to those in touch with it, who have probably spent not more than from £3000 to £8000 on its purchase and equipment, be a profitable venture. Such a mine, if it paid £20,000 in profits before becoming exhausted would, no doubt, have returned the capital sunk in it, with interest. But where would such a profit be as regards a London Company? The consulting engineers', directors', and office-rent expenses—expenses unknown to the small Victorian-owned mine—would absorb this; and the capital of, say £80,000 or £100,000, with which the mine would be saddled, would receive no dividend at all.

I am not necessarily praising the Victorian method of running a mine, as compared with the London method. What I wish, rather, to point out once more is that the small ten or twenty stamp

mine with a large capitalization is almost sure to be a failure. It is not in the nature of such a mine that it can produce enough ore to pay off a big capital.

Another reason why Victorian quartz-mines are not owned to any extent in Britain is because the Victorians work their own mines, and will not sell these except at more than they are worth. Should a new mine be found, money for its purchase and development can easily be raised in Melbourne, Ballarat, or Bendigo. If this property in due time is transferred to an English company, the probability is that a bigger price has been paid for it than its prospects warrant.

Amongst the London-owned Victorian quartz-mines are the **Bethanga Gold-fields, Eagle-hawk Consolidated, Forest Creek, Maryborough Leviathan, Victoria Proprietary, Victorian A 1, Victorian Cornish, and Victorian Standard.** These eight mines are all small producers. One treats as much as 3000 tons a month of a very low-grade ore, another treats 500 tons, and the rest smaller quantities. Their profits, if any, are insignificant, as are their ore-reserves.

In spite of this, the average issued capital of each of these mines is over £87,000. Had they been locally owned their capitals would probably have averaged £20,000, and even at that figure their prospects would have mostly been doubtful.

The British-owned quartz-mines in Victoria, mostly small and over-valued, must not be confused with the British-owned "deep lead" alluvial mines there, which are ventures of a different kind. These are mostly big mines, and under certain conditions may become successful. Their gold-contents are probably great. This fact, combined with the struggle now in progress to master the great flow of water, makes the future of this group of mining ventures the most interesting mining problem in Australasia.

In describing these mines I shall quote at some length from their official reports :—

“ . . . In former geological times the central and northern portions of Victoria were inundated by vast volcanic flows of lava and basalt. These molten rocks buried portions of the ancient river channels and largely obliterated the ancient valleys. . . . Some of these river systems drained areas containing widely-distributed gold veins, and from these regions large amounts of sand and gravel were washed down by the streams and deposited along the bottoms of the ancient valleys. The gold contained in these sands and gravels was concentrated by nature near the base of these beds, i.e. near the ‘bedrock.’ These gold-bearing strata are the so-called Deep Leads, and the gold-bearing sand and gravel is usually referred to as the ‘wash.’ The leads thus follow the bottoms of the ancient valleys, and have in general distribution all of the characteristics of modern drainage systems, with tributaries opening into larger streams and eventually into large trunk rivers and valleys. There are many of these lead or buried-river systems in the state, the existence of which has been proved by systematic diamond drilling, largely carried out by the Government.”

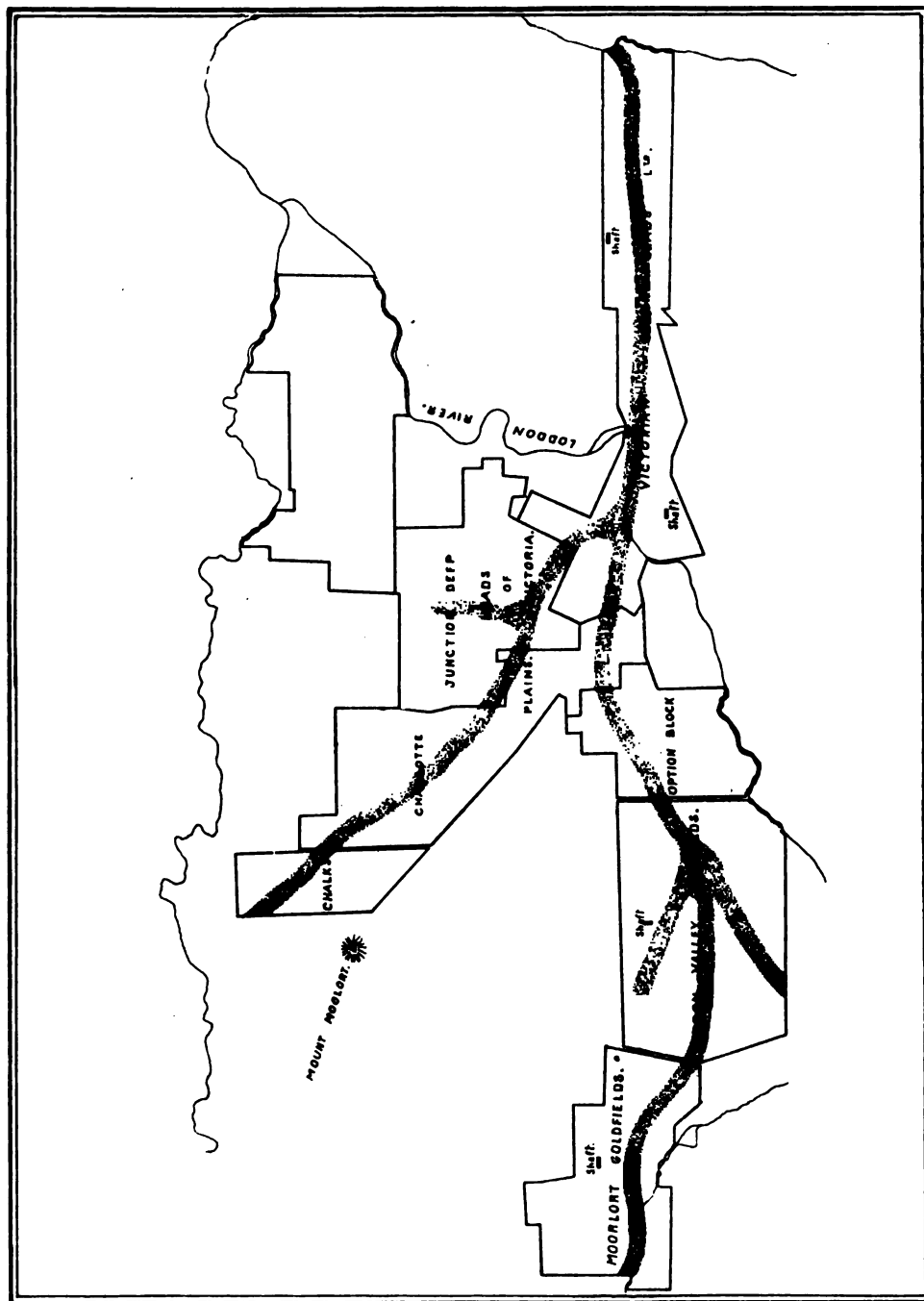
The Madame Berry lead system is looked on as the most important in Victoria, and on its main trunk, or on tributary leads, are located the group of British-owned mines.

“This lead system has been the most successfully worked of all those in the state, and had its source in the well-known quartz-mining regions about Ballarat, Creswick, and Clunes, and nowhere that this lead has been worked has it proved unprofitable. North of Creswick a number of tributaries combine to form a well-defined main trunk lead which has been traced by borings following approximately the course of the present Loddon Valley for a distance of some forty miles northward. The section of this lead referred to begins about twenty miles north of Creswick, extends through the property of the Moorlort Goldfields, Limited, a distance of three to four miles along its course, thence through the property of the Loddon Valley Goldfields, Limited, a distance of about four

to five miles, receiving within this property a tributary from the east—the Loddon Lead—and from the west a minor lead discovered within the property. Adjoining this area, to the north, are the Option Blocks, covering about two-and-a-half miles of the main trunk lead, which near the southern boundary of the property receives a very important tributary, the 'Majorca' Lead, the combined leads passing thence, after a short interval, through the property of the Victorian Deep Leads, Limited, for a distance of about ten miles. There is thus within this section a total length of twenty-one miles along the Madame Berry Lead, not estimating any of the tributaries.

“The thickness of the deposits overlying this ancient river varies from 250 ft. to 400 ft., the width of the ancient valley varying from two to five miles. The 'wash' or gold-bearing strata next to the bedrock varies from 2 ft. to 5 ft. thick, and the width of the wash from 400 ft. to 1500 ft., its length being, of course, the full twenty-one miles of the lead within this section. Overlying the wash there is from 50 ft. to 260 ft. of debris, composed of gravels, sands, and clays, and overlying this, for the most part, a considerable thickness of lava and basalt. The extreme northern end of the Victorian Deep Leads ground is not covered with lava. The beds of alluvial and debris lying between the lava and the bedrock are of a highly porous character, and are saturated with water, which must be pumped out before mining operations can be undertaken. In the shallow tributaries this was but a small problem, but it has been of increasing difficulty, entailing more powerful appliances involving much larger capital, as these tributaries have been worked down farther and farther towards the main trunk leads. It has not been until very recent years that any attempt has been made to pump out what was at one time considered to be the inexhaustible quantities of water contained in this main trunk section.

“The value of these properties, as of all other deep leads, must depend upon two factors: first, the value of the 'wash'; and



LODDON VALLEY SYSTEM OF DEEP LEADS.



second, the amount of water necessary to cope with in order to gain access to it.

“The method of working is, briefly, to sink a shaft, usually at one side of the ancient valley ; from this shaft to drive a tunnel under the bed of this valley, and, after the erection of large pumping appliances, to put up boreholes to drain off the water contained in the porous beds above. After the water has been exhausted, the mining works are carried out in the ordinary manner. The gold is very easily recovered from the wash. Rough puddling is done to disintegrate the clay and pebbles, and then this material is washed over riffles to catch the gold.

“It is possible to approximate the amount of porous material overlaying the bedrock and underlying the lava in most instances. From this can be estimated the actual water contents. The overlying lava and clay seams offer an effectual roof against percolation from the surface. So much is this so that in the Berry Consols Extended Mine, after exhausting the water of saturation, not enough was secured from the mine to treat the material brought to the surface.

“It is not necessary to pump out the water saturating the whole of these porous beds before working can begin, because after the greatest portion of the hydrostatic pressure is overcome, the water is held back by capillary attraction, and thus each point of pumping becomes, so far as the water level is concerned, a sort of inverted cone. The pressure of water disclosed at the Moorlort and Loddon Shafts in the first instance was about 136 lb. per square inch, indicating a column of water of about 255 ft. high.

“It is obvious that it is impossible to estimate the value of ore buried 200 ft. to 450 ft. below the surface, which has not at any point been actually entered. The probabilities of value must rest upon three bases, i.e. the results of bores ; previous experience elsewhere on this lead ; and the geological probabilities. The bores put down from the surface, mostly by the Government, have been of small

dimensions, and designed for tracing the actual location of the lead, rather than sampling. Gold has been found in most of these bores situated within the wash. In the mining operations upon the Moorlort and Loddon, water-bores have been put up vertically from the workings, to let down the water, and these bores indicate very high values indeed; but from the scouring action of water under great pressure, the amount of gold is probably beyond due proportion. These bores indicate values of from 16s. to £16 per ton; but, as said, they must be accepted with caution.

"The upper reaches of the lead have, on working, uniformly yielded large quantities of gold, and large profits—the Madame Berry Lead over £5,000,000 from something over seven miles, and the Majorca Lead over £2,000,000. From these yields, dividends of upwards of £2,500,000 have been earned. In no case on the main lead have the mines failed to be profitable.

"The geological probabilities are based upon the fact that all rivers transport gold long distances along their courses, and, aside from the richness of this ancient river, wherever worked above, they drained an area containing large numbers of gold-bearing veins, and the country rock itself contains more or less gold in small stringers, etc., all of which has been concentrated by nature into the wash. Several tributaries also carry gold into the main lead and enrich the main trunk.

"As said before, what the yield will be per ton cannot be anticipated, but, in general, the probabilities of payable results are very favourable. The quantity of wash available is very great, probably varying between 500,000 to 1,000,000 tons per mile along the lead.

"The cost of working, when once the water is drained, is very low. Working upon the large scale intended, the material can be mined and treated for about 6s. to 7s. per ton."

The two problems, then, which these mines have to face are the

amount of gold in the "wash" and the quantity of water that must be pumped before this can be got.

As to the first problem—the amount of gold present—the evidence is satisfactory. There is, of course, no certainty, for one cannot reach this ore and sample it as is done in a quartz-mine; but the gold recovered from the lead in its shallower reaches, and the results from an increasing number of boreholes, are facts which cannot be set aside.

A geologist on the Government survey of the United States, after spending some months on this deep-lead system, reported on the gold-value as follows:—

Of the Moorlort:—"I think the probabilities are strongly in favour of a payable run of gold being found."

Of the Loddon Valley:—"The Loddon lead drains some of the richest territory in the State, including Maldon, Muckleford, Castlemaine, Fryerstown, Vandoit, Jim Crow, and Green Gully. It must contain a large quantity of transported fine gold. Besides, it crosses an important reef line four or five miles above its junction with the Berry-Moorlort lead, containing a considerable number of payable quartz-reefs, and a number of celebrated old alluvial diggings. I feel sure that that part of the Loddon lead which falls within the boundaries of the lease here considered will be highly payable."

Of the Option Blocks:—"I should be inclined to believe that the whole of the lead in the Option Blocks is payable."

Of the Victorian Deep Leads:—"As far as can be judged from the few data at hand, I believe the lease to be an excellent property for deep alluvial mining."

These statements are of course based on incomplete data, and are not final; but they show the technical opinion as regards these mines.

The second problem—the water question—is more serious. The ground covering the wash to a depth of 250 feet, and lying below the volcanic rock, is a perfect sponge—a veritable underground sea. It is only logic to believe that this must eventually be pumped out;

but the time occupied in pumping, and the big outlay of money on machinery and fuel, are most serious factors.

Pumping has been proceeding on parts of the lead for several years, intermittently. In December, 1904, the pressure at the Loddon Valley shaft, which a year earlier stood at 78 lb. to the inch, had been lowered to 34 lb. It suddenly, however, shot up again to over 50 lb., though at the time of writing this it has again fallen to 44 lb. At that figure it is being held, on a daily pumping of about 4,500,000 gallons.

The pumps at this shaft—which is the most advanced on the lead—as originally designed, were too small. These have been enlarged and strengthened from time to time; but it is evident that before the water can be thoroughly mastered the pumping capacity must be much increased. This is now being done. The cost of the long delay and the duplication of plant, not only on the one mine, but on all, will be heavy. Fortunately, between them the companies have considerable cash resources to meet it.

It is conceivable that the water in these mines never will be mastered, and that when the companies have come to the end of their finances they will give up in despair. I, however, believe that before such a financial position has been reached, the water will have been overcome and the "wash" will be in course of development.

The principal group of mines—those on the main track of the lead—are Loddon Valley, Moorlort, Victorian Deep Leads, and Option Blocks. The parent Companies are the Australian Commonwealth Trust and the Consolidated Deep Leads.

On tributaries of the main system are located the Charlotte Plains, Junction Deep Leads, Loddon Deep Leads, and Berry Glengower.

The **Australian Commonwealth Trust** owns options on as yet unfloat ground on the Madame Berry lead. It is also entitled to one-fifth of the profits of Loddon Valley, Moorlort, and Victorian Deep Leads for ten years from July, 1903. The Trust will assist to

finance these three companies till they succeed in getting rid of the water.

The **Consolidated Deep Leads** owns an interest in the Australian Commonwealth Trust. It also owns the whole of the Option Blocks ground and a large number of shares in Loddon Valley and Moorlort. It is assisting in the finance of the subsidiary mines.

Loddon Valley is the mine where the most pumping has been done, and, assuming the water is overcome, it will be here that the "wash" will be first exposed. It is therefore a test-mine, both as regards the water and the gold.

The length of this mine is over four miles, and indications are that it is peculiarly well located for carrying a rich "wash." It has been estimated, assuming the lead to vary in width between 500 and 1000 feet, that the yield of gold ought to be £1,700,000. Of this one-fourth at least ought to be profit. These are thought to be conservative figures, for if the ground can be worked at all, indications are that it might produce considerably more than this.

The wash, if all worked, would probably take fifteen years to exhaust.

Moorlort. This company has a stretch of over three miles of lead. Pumping has been in progress for some years. It is not so far advanced as on Loddon Valley, although the exhaustion of the water in that mine would naturally assist in draining Moorlort.

On a length of 20,000 feet and a width of 800 feet, it is estimated that this ground might last for fifteen years, and produce over £1,300,000. Assuming a profit of between a quarter and a third of this, a sum of nearly £400,000 is indicated. As in the case of Loddon Valley, these figures are supposititious; but the indications of good values are favourable.

Victorian Deep Leads. The length of this mine, about ten miles, is more than double that of the others. This is a strong point in its favour. The depth of water-bearing ground here, too, is not great, indicating less pumping to be done. Up to the present fewer bores have tapped the "wash" on this mine; but some of these

have given high results, and the general prospects do not appear to be less hopeful than in the other mines.

The **Option Blocks** ground is over two miles in length. There has been no pumping done here as yet, but the pumping at the mines on each side will greatly assist in lowering the water-level. It seems probable that this will turn out to be payable ground.

With regard to this group of mines it must be realized that until the water has been definitely mastered they have nothing but a speculative value. After that, and when actual figures of gold contents begin to be available, they may be found to have great intrinsic value. The probabilities are in their favour.

By the time the water has been drained the mines will be in debt, and will still have to wait, perhaps a year or more, until the ground is sufficiently drained and blocked out to be worked. But if the water is mastered, there should be no trouble in setting their finances right by issues of shares or debentures.

The working of these mines would appreciably raise the output of gold in Victoria.

The **Charlotte Plains** Mine is on a branch lead. Borings indicate that its ground is payable. Pumping has been in progress for some years. There is less water-pressure here, and the "wash" should be exposed during 1905.

The **Junction Deep Leads**, **Berry Glengower**, and **Loddon Deep Leads**, are not as yet advanced in pumping.

Duke United is a producing mine on another lead system. It is not rich, but is expected to earn further profits for a number of years yet.

The **Hepburn** is a poor mine, on another lead.

The facilities in Victoria for gold-mining are exceptional.

There is a temperate climate; in most of the districts water, fuel, and mining timber are at hand; nearly all the fields are connected



EXAMPLES OF SADDLE REEFS, BENDIGO



by railway with the centres ; and excellent mining machinery, made at several towns in the state, can be landed close to most of the mines. To these must be added a cheap scale of living. The ore is easily mined, and needs only stamping and concentration, and the concentrates find a ready market locally. The gold being so free, no after-treatment of tailings is required, and the value of the bullion often runs up to 81s. or 82s. The scale of fees paid to secretaries (or legal managers) and directors is very modest.

In none of the Australasian states is black labour allowed underground, and the miners are banded into strong unions. The rate of pay in the principal mining districts of Victoria is 7s. 6d. per eight-hours day, or 45s. a week. In some parts it is 50s., and for driving or sinking in wet or hot ground this figure would be paid. The Australian miner is a fine workman naturally, but the teaching of the union is that one man shall not do more work than another. As a result the standard of work adopted is that of the worst or feeblest workers. Contract work is sometimes asked of the men, more especially in the deep-lead mines, but this method of work does not find favour with the unions.

Comparing mining conditions in Victoria with those in California, where they are equally good, it may be said that the Californian mine is liable to have a big ore-body, of low value, requiring an expensive equipment ; whereas in Victoria the mine is smaller, though of richer value, and can be started for a less sum of money. The net result in each case is much the same.

The gold-reefs in Victoria are usually of a milky-white quartz, and, taken all in all, have proved as treacherous as white quartz-veins in other parts of the world. Here and there an ore-chute has continued payable to 2000 ft., or even to a greater depth, and the present workings of some of the best mines in the state are well below 1000 ft. But on the whole there is only one way of valuing these reefs ; i.e. to expect that at any moment the chute may be found to have come to an end, and to allow for not a single ton of ore beyond what is actually exposed.

The reefs are of all sorts. Many, and often the richest, are mere gash-veins, and die out at 100 ft. or 200 ft. A great number have given out at about 500 ft. Lenses of ore, short and thick, and lying at an oblique angle, or often quite flat, are a common form of occurrence. These are hard to locate, as they often do not come to the surface, but often produce bunches of good value.

Every here and there is found a master lode, going right down, and carrying payable values to, perhaps, over 2000 ft., and the peculiar saddle-reefs of Bendigo have even produced some pay-ore from 3000 ft.

On the whole, the actual mining work is done well. The managers, as a rule, are men who have risen from the ranks, and, for the small rate of pay they receive, often not more than £4 a week, are efficient. These men, capable in their own sphere, have a hearty contempt for scientific methods. They do not handle the accounts, which go through the legal manager's office in one or other of the towns, and have no more than a crude idea of the figures. A scientifically drafted cost-sheet is almost unknown on a Victorian mine.

Systematic assaying of the ore, and estimation of the ore-reserves, is never carried out. Victorians laugh at the notion. They point out that the gold is nearly all free, and that by panning the manager can tell what is payable; that sampling and assaying do not put more gold into the ore, but that, nevertheless, they entail a larger staff, and other expenses of various sorts.

Such a thing as security for the shareholders, or an approximation of the mine's true value, are not essentials with them. The usual policy, about which no secret is made, is to mine the richest ore available at the time, to keep only a few months' reserves in sight, and to let the future take care of itself.

On this basis of always taking the best ore first, accurate sampling and estimation of reserves certainly lose much of their importance. This sort of mining is all right for the man living close to the property, who can go there several times a month, and see how

things are going ; but for the shareholder at a distance, especially for the layman, there is exceptional risk. Nothing would induce me, however big current dividends might be, to accept their evidence as a reason for buying shares in any locally controlled Victorian mine.

These companies are floated under the "no-liability" law.

On the flotation of a no-liability company, a first call is made against the shares—of perhaps 2s. or 3s. only ; the holder of this scrip, or any subsequent purchaser, may be called upon by the company, at several weeks' notice, to pay a further call, or a series of calls, until the full value of the share, which is usually for 10s. or £1, is paid up. Should the holder not be satisfied with the prospects of the mine, and, therefore, not anxious to pay the calls, he forfeits the shares, which revert to the company. If they have any market value, the company sells them by auction, refunds itself the amount of the call due on them, and pays the rest to the forfeiter.

This "no-liability" system of flotation is sound enough in theory, but in practice it acts badly. The working capitals provided are so small that in no case are they sufficient to bring the mine to a producing stage. This means that one or more "calls" have to be made. If the mine is not promising well, the shareholders do not pay the call, the mine is shut down, and the money already spent is wasted ; whereas the mine may be all the time a good one, which would have disclosed its value had enough capital been put up originally to fully develop it. On the other hand, the mine may be in a promising condition, and the shareholders pay the calls. But the call is for the absurd amount of only 1d. or 3d. a share a month, and the money so raised—perhaps £400 or £600—is only enough to do bare development work, and not enough to prove whether the mine has really possibilities beyond the ordinary ten- or twenty-stamp capacity which seems to satisfy local mining men.

When profits are earned they are immediately paid away in dividends, and nothing in the shape of a reserve fund is set aside.

There are mines, earning regular profits, with presumably long lives, where the cessation of the monthly dividend for not more than three or four months, and the purchase, with this money, of labour-saving appliances, would materially reduce future costs. Rock-drills, rock-breakers, self-feeders in the mills, and good concentrating tables, are scientific luxuries which the Victorians are apt to despise; many managers will go without these for years rather than fail in producing their monthly dividend. In this respect many of the Victorian mines are thirty years behind the times.

The most important quartz-mining district in Victoria is, and has always been, Bendigo. Here the reefs are found in the usual "saddle" formations, notwithstanding which they have proved more reliable in their values and more profitable in their work than any other lodes in the state. The district has been worked over fifty years, but still produces £750,000 annually. Many of the best mines, however, are exhausted.

The saddles lie one under another, and the formation carrying them seems to extend to a greater depth than mining is possible. But there is hardly occasion to sink to exceptional depth, for relatively little gold is found below 2000 ft. vertical.

There are probably a dozen shafts sunk to 3000 ft. or over. In the **New Chum Consolidated** I went down to a depth of 3550 ft. At this depth, which was at the bottom of a 500 winze, the temperature of the air was 90°, and of the water falling into the winze 91°. There was a large reef exposed of dull white quality, but carrying no gold, and for 1000 feet above this there had been no payable ore.

The **New Chum Railway** worked some good ore at 2800 ft., and since I was last in Bendigo several of the saddles below 2000 ft. have produced more or less payable quartz. But I should say that the net result of the work done below 2000 ft. shows a loss, and would consider it more profitable work to reinspect the ground at, say, between 800 ft. and 1500 ft. than to go on sinking below 2000 ft.

The future of the field lies, not with the older New Chum and Garden Gully lines of reef, but with outside and hitherto little-known saddle formations—principally those in the direction of Eaglehawk. In this part of the field, too, the reefs are found of greater width, and can be worked on a larger and more regular scale.

Up to the present most work has been done on the New Chum line, and on this line most of the 3000-ft. shafts are located. The Garden Gully line has also been exploited to considerable depth.

In Bendigo itself the Hustler's line is not yet worked so deep as the others, and may still furnish much good ore. The **Hustlers No. 1** and **Fortuna Hustlers**, when I saw them some years ago, were working at comparatively shallow depths.

The future, however, is with the Eaglehawk district, a few miles distant, which carries the natural extension of the Bendigo zone. Here are located the **New Moon** and **South New Moon**, which have for some years been the best mines in Bendigo. These carry very big ore-bodies. They pay big dividends; but who is to say what their value is? The ore is never assayed, and what proportion of the reserves is payable and what not payable is a problem I don't attempt to solve.

Bendigo is the chief of a number of centres in the main gold-belt of Victoria. Many lines of reef, worked at different places in the belt, have been already nearly exhausted; for instance, those at Ararat, Clunes, Stawell, Daylesford, Castlemaine, Maldon, and Ballarat. I do not say these districts are worked out—for new mines are from time to time found or old mines reopened, sometimes with good results—but I suppose the best ore has been taken from them.

At Ballarat numerous mines still produce, but they are all small, and this field in depth is certainly poor. In the districts to the south of this, at Scarsdale and Berringa, several good mines still exist.

In Gippsland the mines are scattered over mountainous, forest-clad country, much of which is yet unprotected. All the reefs here are heavily mineralized, and generally refractory. There are no railways, and facilities are less than on the main belt.

The best mine in Gippsland is now **Long Tunnel Extended**; in depth this appears to have got most of the chute once worked in **Long Tunnel**, a mine which paid over £1,000,000 in dividends. The boundary line of these mines is so located that part of the ore-chute should, in depth, be again found in Long Tunnel, and an amalgamation of both mines would be judicious.

In the north of Victoria there is the big deep-lead system of Rutherglen and Chiltern. This is worked entirely by local capital. It has been, on the whole, a failure. Many of the mines did not produce enough gold to pay their current pumping expenses, while the heavy pumping of the years during which the lead was draining was a dead loss.

Gold-dredging in Victoria, at first a failure, has become very profitable, and is expanding. In the Castlemaine district alone there are now thirty dredges, and there are also a number in the Bright and Omeo districts. For the last five years Victorian dredges have produced altogether £1,100,000. This figure, analyzed, shows a yield of 4½d. per cubic yard, or £636 per acre.

New South Wales. Gold is found in many parts of this state, but a material concentration of the metal in any one deposit is unusual. Nearly all the quartz-mines are small, and most of these floated from time to time as British companies, have been failures.

In a number of places, notably at Wyalong, parties of working miners make a living—sometimes more than this; but such reefs as they work, though rich, are narrow and faulted, and would not stand the costs incidental to a larger organization.

As an individual producer the **Mount Boppy** is the only notable gold-mine in New South Wales. Lying far in the interior, it is fortu-



MOUNT BOPPY MINE



nately only a few miles from a railway. Fuel is plentiful, and the labour supply is reported to be satisfactory. On the other hand, the water supply is uncertain, and stoppages on this account are a contingency to be reckoned with.

The lode, proved at present to 400 ft. deep, forms a substantial ore-body, both as to value and bulk. Its gross value approaches £3 a ton, and in places the ore is found up to 30 ft. wide.

The present reserves are placed at 170,000 tons, or about 3½ years' supply for the sixty-stamp mill. The average value of this ore is not stated, but I assume it approximates to the value of the ore treated in 1904, which yielded 51s. 9d. per ton.

The future of the property, after the next few years, is at present in doubt. A fault runs across the mine, reducing the length of payable ore at each level, and at a depth of 500 ft., or 100 ft. below the present bottom of the mine, it seems possible that the whole of the pay-ore will have been cut off.

Beyond this fault or slide, no ore has yet been found ; but at the time of writing this the exploratory work for the lost reef has not been so complete as to preclude the possibility of its existence. Very much depends on this. Good as the mine is on the upper side of the fault, and considerable as is the quantity of ore yet to take out, the real future depends upon the mine below, not above, the disturbance.

The valuation of the mine at present is about £500,000. The net profit in the 170,000 tons of reserves is—on the 1904 basis of yield, and allowing a small further reduction in costs—about £255,000. The cash in hand is required for capital expenditure, and does not affect the position.

The ore-reserves, therefore, have a profit in sight equal to 51 per cent of the mine's market valuation. This would be insufficient if the prospects in depth were unimpaired ; as they are—for the present at least—seriously menaced by the fault, the discrepancy is altogether too great.

Not far from Mount Boppy is the Cobar district. A remarkable

lode exists here, of great width, and running for some miles without a break. This vein carries gold, silver and copper, in different places, but in all the mines, in depth, the copper is found to predominate.

The **Cobar Gold Mines**, an English Company, was a good mine in the upper levels. It has 100 stamps, and for a number of years has been milling low-grade gold-ore, with a small profit. The lode is of great width, probably averaging 40 ft. At about 300 ft. deep, copper showed itself to be replacing the gold. The presence of this metal is, of course, fatal to cyaniding; and as the bulk of the gold has in the past been secured from that source, the future of the mine cannot but be doubtful.

The mine seems now, or at such time as its gold-ore shall be exhausted, to be neither one thing nor the other. The small gold contents cannot be extracted profitably in the presence of copper, and the copper is not rich enough, and the ore too silicious to allow of smelting. The company has some cash in hand. It is possible that the Great Cobar copper-mine would pay a fair price for this mine as a metal-carrying flux for its own ore.

Farther along this lode is the **Occidental**, also worked as a gold-mine. Here the formation has been taken out in an open cut, 50 ft. wide and 150 ft. deep. This is also a low-grade mine, and will no doubt turn to copper in depth. Its fate will possibly be absorption into the Great Cobar.

Amongst other London-owned mines are **Royal Oak of Hauraki**, exploring the extension of the Mount Boppy, **Gibraltar**, **Mitchell's Creek**, where there is some payable ore, but an inflated capital; **Lachlan**, which has earned profits for the last year or two; and **North Lachlan**. These are small.

There are several dredges at work in the country.

Queensland. The coastal mineral belt of Queensland is over 800 miles long, and 200 miles wide. Much of this has never yet been

properly explored for minerals. The gold-mining centres are at Gympie, Mount Morgan, Ravenswood, Charters Towers, Etheridge, Hodgkinson, Croydon, and the Palmer. These are small fields. Most of them are embraced in a few square miles; and yet they represent all the quartz-mining that is being done over such a great mineral area. One cannot believe that these deposits exhaust, by a long way, the payable gold-mines in the state.

These gold-fields have mostly been worked for many years, and are slowly but surely decaying. The Palmer, Hodgkinson, and Etheridge are now worked on the smallest scale; while Ravenswood and Croydon are not of much importance. Charters Towers and Gympie—two fields that have passed their zenith—and Mount Morgan—a single mine—have between them to produce the great bulk of the present output. That they can long continue to do this is, I feel sure, not possible, and I look for a falling return of gold from Queensland as surely as from West Australia.

The question is one for the state Government to take in hand. The gold-mining industry is one of Queensland's chief assets, and a narrowing of its sphere would affect the revenue in many ways. A few thousands spent during the next few years—say at the outside £100,000—might alter the outlook altogether, and repay the Government for its expenditure ten times over.

This great mineral belt must carry many undiscovered potential mines, and properly equipped exploring expeditions might be relied on to find a number of these. As in the case of West Australia, I would supplement these expeditions by financing a few hundreds of the old-time fossickers, many of whom are still to be found round the alluvial diggings.

If the Government decides that prospecting for gold is not one of its functions, and takes no steps in this matter, both the country's yield of gold and the revenue of the State will in a few years have fallen materially.

As in Victoria, the Queensland mines are not assayed, and no attempt is made to arrive at the quantity and value of ore-reserves.

The manager, by panning, can arrive at a shrewd idea of what is good and what is not ; this, however, is done with the object of locating the richest ore in the mine, which is invariably worked out first. The yearly reports of all Queensland-owned and controlled mines should be headed with a paragraph in thick type, reading thus :—

NOTICE.

The ore in this mine is being picked ; the richer ore is now being mined, and the poorer is being left behind. The directors make this statement in order to warn investors in England, or those unacquainted with Queensland methods, that the current dividends represent the working of the richest ore only. The amount of such ore is unknown, and the directors do not guarantee the present high rate of dividend for any definite period.

I do not wish this to be taken for sarcasm, which is not intended. These Queensland directors no doubt wish to do the right thing by their mines ; but if they could realize the harm they have done to that country in England, in the last year or two, they would begin to understand my point of view. Let me explain to them that in all good gold-mines in other parts of the world, where honourable men are at the head of affairs as managers and directors, two things are taken for granted.

The first is that the ore shall be systematically sampled, and the quantity and value of the payable reserves stated in all reports.

The second is that, unless the shareholders have been advised to the contrary, the ore treated over any given period shall truly represent the average value of the pay ore blocked out in the mine at that time.

The British investor has looked for these things from Queensland mines, and has failed to get them. Where he should have had statements about ore-reserves, the reports that were sent him left this subject alone. He was entitled to believe, as nothing was said to the contrary, that the ore being produced was a fair

average of the ore in the mines ; while all the time the managers were picking out the richer sections.

The directors of various Queensland mines must have known what was going on, and cannot be held as lacking in the responsibility for what was done. Synonymously with the large yields and profits, many of the big Queensland shareholders, who knew the limited area of the richer ore, were selling their shares to England. It is not creditable to Queensland directors, as a body, that the adverse information was so carefully kept out of their periodical reports.

Even the Mount Morgan mine was picked, for years. I am glad to think that the technical controllers of this mine, who hold a more responsible position than the managers of the mines at Gympie or Charters Towers, were not directly responsible for this.

Gympie lies about a hundred miles north of Brisbane, and twenty-five miles inland. It is about the southern point of the mineral belt.

The first find of gold here was made in 1867, and ever since the field has been an important quartz-mining district. The town now supports a population of 12,000, almost all of whom are directly interested in gold-mining.

Many of the older mines, after paying well, are now worked out, but others holding deeper ground have been floated. At the present time there are probably 80 or 100 companies ; but most of these are shut down and only a few work at a profit. These mines have been financed and developed with local capital, and consequently economy has been a feature of the management. Sometimes this economy has been carried to excess ; the shafts have been made too small, for example. The directors are all practical men, paid with modest fees, and can be relied on to give good advice and careful supervision.

Results, in the aggregate, have been excellent. A number of the mines in past years, with small capitals to work on, paid great sums in profits.

The occurrence of gold on the Gympie field is peculiar. Several

parallel beds of slate, dipping at about twenty degrees, traverse the country ; the thickest of these beds is about 200 ft., and the others are frequently not more than 10 ft. thick. In the opposite direction, dipping at a much steeper angle, is a series of strong, well-defined, white quartz-reefs. These reefs are valueless, except where they cut through the slate-beds, but, at those particular spots, they invariably carry gold, which is often highly payable, and is usually found in a nuggetty state. So common a feature, indeed, is visible gold at Gympie, that each mine is provided, underground, with a strong box, which from time to time becomes filled with "specimen" stone taken from the contact of the slate—where it is blackest—and the reef, and worth perhaps £1000 to the box-full.

To prove the continuance of gold in depth at Gympie, therefore, one follows—not the reefs, but the main band of slate. When the first reef is reached it will furnish reserves of ore for 200 ft. in height, that is to say, for the whole distance in which it is found in contact with the slate band. When this is worked out, a cross-cut is put through the slate to tap the next reef of the series which, in its turn, will also produce the looked-for 200 ft., of good value, and so on. Several of the best located-mines have proceeded to work out four or five reefs in this manner, and are still, after long and successful careers, making good profits.

Within the last few years, at Gympie, the deep-level area of the field has been largely developed. As the slate-bands, dipping at twenty degrees or so, reached a depth of from 800 ft. to 1500 ft., it was found that they encountered a new series of reefs, which, valueless elsewhere, as was the earlier series, frequently carried rich gold at the contact of reef with slate. These deep levels have not turned out so well as was expected some years ago ; but a mine here and there is producing gold at a profit.

A Gympie mine usually has an area of 25 acres, and a capital of not more than £24,000, divided into 5s. or 10s. shares. The vendors' interest is in many cases almost non-existent. As the opening up of the mine proceeds, calls are made on the shares

from time to time, but the producing stage has usually been reached when only one-half or two-thirds of the liability on the shares has been called up. This leaves the shares, even of regular dividend-paying mines, with a liability of several shillings, which English investors object to. To add to this drawback is the fact that hardly any of the Gympie mines have London offices. Transfers of stock cannot be effected in England, and should a call be made on unpaid shares, the holder at a distance who does not receive adequate warning is liable to have his shares forfeited. A central London transfer office should be established, where also all information from the field, showing the progress of each mine, could be secured.

Scottish Gympie. This is one of the deep levels of the field. At this point the black slate-band came in contact with the reefs at from 1400 ft. downwards. As it is here 250 ft. thick, "backs" of a similar height can be estimated on. The ore-formation in this mine is tremendous. I have measured it in one spot 300 ft. wide; the whole of this carried gold.

In 1900, on the data then available, I estimated that, with backs of about 250 ft., and allowing 40 per cent of the ore to be rejected and used as filling for the huge cavern to be made, there were something like 600,000 tons of ore still to take out. This was on the one lode only. There was a chance of opening other ore-bodies.

More recently the mill has been increased to 125 stamps, and the ore treated is now over 80,000 tons a year. The value, with the bigger mill, has fallen slightly, but good profits are still being earned.

Assuming that no other reef will be found payable, the mine seems now to be over-valued.

No. 2 South Great Eastern. On this mine the main slate-belt cuts several reefs at about 1300 ft., and the backs are figured to average between 200 and 250 ft. high. Four reefs are worked.

Rich as this mine has been and is, it has no long life ahead. When the present series of reefs is worked out—or rather, the 250 feet of them lying in the black slate—the mine will be finally exhausted.

A private estimate made at the end of 1903 showed a presumable ore-reserve still available of 310,000 tons; or, say, enough to last till 1910. But as to whether all this was payable ore, and what was the average value, the maker of the estimate spoke guardedly.

It is painful to think that on a big mine of this sort there is no systematic assaying, and that shareholders cannot receive any accurate statement of what their property is really worth. A recent fall in the grade of the ore leads one to think that the richest ore is already exhausted. If the directors had advised the shareholders two years ago that the richest ore was being taken out, they would have been only doing their duty. If they reply to this that they themselves did not know this was being done, is it not an argument in favour of future sampling and scientific ore-valuation? Why should the good name of mining suffer for the carelessness of individuals?

Most of the Gympie mines are only owned locally.

Three hundred miles north of Gympie, and a few miles inland from Rockhampton, is **Mount Morgan**, the best gold-mine in Australasia.

It was discovered in 1882. In 1889 it reached its zenith, and in that year £1,100,000 was paid in dividends. At the present time, with depth, the ore has become much poorer, and figures like these will never again be reached; but the mine will earn large profits for many years to come.

The whole of the mount in which the huge deposit lies is being slowly quarried away. This process has been much assisted lately by the use of steam shovels, and the outline of the hill would now be unrecognizable to those who have not seen it for some years.

By the use of these shovels one can cheaply remove masses



MOUNT MORGAN—THE OPEN CUT

of overburden, and it has been possible to reach quantities of low-grade but payable ore that had become buried, and was thought to be lost to use. These supplies, added to the large quantities of ore nearer the core of the deposit—though no estimate has been made of either quantity or quality—will no doubt last for a number of years. The value of this will be a good deal less than what it was up till 1903. Up till that date the richer ore was picked out. Presumably this was done on the instructions of the then managing director. But would it not have been better to take the shareholders into his confidence? Nevertheless, there is a big profit still remaining in the old ore.

But like the Cobar gold-mine, Mount Morgan has become a copper-mine in depth. At the 750-foot level the ore, which had been gradually losing its gold value below 500 feet, was found to carry material value in copper. A great deal of diamond-drilling to determine the extent of this gold-copper area, followed by development work, then took place, with the following results.

At the 750-foot level there is a gold-copper deposit covering $1\frac{1}{2}$ acres in area. Development has outlined in this deposit the existence of 2,461,000 tons of ore. Nearly half of this carries 33s. 6d. a ton in gold and 3·5 per cent copper, while the remainder carries 10s. 6d. a ton in gold and 3 per cent copper. Further quantities, worth 6s. 3d. in gold and 2·5 per cent copper, have been located, but these are not included in the estimate. This ore will be treated by smelting, and the first half of the plant, with a capacity of over 10,000 tons a month, is now being erected. The poorer ore will probably be leached for its copper contents.

The total value of the exposed gold-copper ore, reckoning copper at £60 a ton, is £7,129,000; and the cost of plant, treatment, and loss in treatment, is figured at £4,640,000. The net profit is placed at £2,489,000.

In my estimate of the value of Mount Morgan I take the copper as worth only £55 a ton. Over a period of years this seems a more conservative average price to rely on. On that basis the net profit in the gold-copper ore already exposed is £2,108,000.

A valuation for the whole mine shows :—

(a) Say, five years' gold ore reserves in sight : net profit on this £ 650,000	
(b) Gold-copper ore in sight: net profit 2,100,000	
(c) Cash 150,000	
Total, £2,900,000, equal to £2 18s. per share.	

Beyond this, the prospects of the mine, both as to further gold-ore and gold-copper ore, are hopeful.

The next field to the north is Ravenswood. This locality was first prospected in 1870, but was almost deserted after the discovery of Charters Towers.

The reefs of Ravenswood, though sometimes rich, are most refractory. This entails smelting the ore; and as the total costs under that head, including mining, sorting, bagging, rail to Townsville, freight to smelter, and the usual deductions by the latter, work out at between £5 and £6 per ton, the field has been always much handicapped.

The **New Ravenswood Company**, formed a few years ago, took up four of the best mines on the field, and on a small capital has earned good profits. No doubt an organization of this sort, when its present mines show signs of exhaustion, will be able to secure others, for it is probable that the good ore of the field is not yet worked out.

The **Ravenswood Deep** is testing some of the deeper ground.

Near here is the Donnybrook district. The small, rich reefs located a few years ago, are now worked out. The **Donnybrook Blocks**, an English company, working a reef several inches wide, produced some hundreds of tons of ore, but is now not working.

Charters Towers is 50 miles north from here. It is 700 miles

north of Gympie, and 80 miles inland from Townsville, and is the most important point in the Queensland mineral belt. It was discovered in 1871.

The reefs, of which there are a great number, lie within an area of several square miles. They are fissure veins of whitish quartz, lying in solid granite, and where richest, carry frequent splashes of galena and pyrites. The reefs are free-milling, and amenable to cyanide; concentrates are collected and treated locally by chlorination, for which process there are several customs plants. The lodes carry more or less defined chutes of rich ore, but on the whole they are irregular in their occurrence and in their values. Generally speaking, calculations of the value of Charters Towers mines are only safe when they deal with ore actually in sight, and all estimates as to the lives of the mines or their probable dividends, except from ore developed, are more or less guesswork.

There are probably 100 mines in existence within a radius of three miles of Charters Towers, but the majority of these are unimportant, owned locally, and need not be noticed in detail.

The principal lines of reef now being worked, in which British capital is sunk to a considerable extent, are the "Brilliant," "Day Dawn," "Victoria," "Queen," and "Victory" reefs. Apparently the "Brilliant" and "Day Dawn" reefs lie deepest in the series, and as they are also the largest and richest now being worked, the future of Charters Towers may be said to depend upon their productiveness.

Neither of these principal reefs appears to have any great lateral extent, and as they are being worked out, not only by the outcrop mines, but by several rows of deep levels simultaneously, they are gradually becoming exhausted.

After the ore is raised to the surface, its handling is not judicious. To begin with, few of the mines possess ore-bins; the ore is therefore tipped on to the ground, whence it has to be shovelled into carts at an extra and unnecessary cost. It is then carted—not to

the company's own mill, for few of the mines own a reduction plant—but to a customs mill, where it is crushed and roughly concentrated at a cost of 13s. or 14s. per ton. These customs mills usually belong to the local capitalists, who are also directors of the various mines, and it is not to be wondered at that they, in their capacity of directors, never protest against the extortionate charge for milling the ore, which, in their other capacity of mill-owner, goes into their own pockets.

In other departments except the surface handling of the ore, Charters Towers mines are well run. General expenses, secretarial and directors' fees are moderate, and the finance of the companies is usually well conducted. The actual mining work, too, is on the whole of a good standard.

Within the last few years, about seventy small cyanide plants have been erected near Charters Towers to work the old tailings, which for years had been allowed to run to waste, and which have filled the river beds for miles. Returns from these helped to raise the monthly output from the field to about £140,000, but I am of opinion that at about this figure the maximum of production was reached. Some years more of profitable results may be expected from the "Brilliant," "Day Dawn," and "Victoria" lines of reef, but after that most of the now best-producing mines will have been worked out, and I see no new mines likely to take their place.

The "Brilliant" line of reef, or rather the one payable chute on that reef, has been the most valuable ore-body at Charters Towers.

This chute was never found near the surface, but was first worked in the Victory mine, at a depth of 300 feet. From there it passed into the Brilliant, the deep level of the Victory; thereafter, at gradually increasing depths, into the Brilliant St. George, Brilliant Central, and Brilliant Extended. These mines contained the main run of the chute, but fringes of it were also found in the East

Mexican, Brilliant Block, Brilliant Freeholds, and Phœbe. A lot of good ore, too, was found in Kelly's Queen Block. In the **Brilliant Deep Levels** and **Bonnie Dundee** there was little payable ore.

It may be stated, in general terms, that all the payable ore has now been worked out in the **Victory, East Mexican, Brilliant Freeholds, Brilliant Block, Kelly's Queen Block, and Brilliant**. There is still unworked ore in **Phœbe, Brilliant St. George, Brilliant Central, and Brilliant Extended**.

At below 2000 ft. vertical the "Brilliant" reef lost most of its value. It was expected that it would be found in either Brilliant Deep Levels, Brilliant Extended, or Bonnie Dundee, which between them cover all the dip ground. The Brilliant Extended has certainly got some payable ore, although of no great value; but the Brilliant Deep Levels and Bonnie Dundee have nothing.

So far as can be seen, the "Brilliant" reef is now nearing exhaustion. The most valuable blocks of ore yet remaining to mine are in Brilliant St. George and Brilliant Central, and no doubt each of these mines has some years ahead of profitable work; but I know of no other mine on this line with assured prospects.

The directors of Brilliant St. George and Brilliant Central, who by now must know approximately the amount of ore remaining in those mines, should make some statement as to quantities and values. In this course they would only be following the custom set by the best-managed mines all over the world. There is no reason why Queensland mines should shirk such responsibility.

The mines on the "Day Dawn" reef also give the idea of an approaching exhaustion.

The **Day Dawn Block and Wyndham**, the most important of these, is now earning a bare profit. It is, however, to be noted that this company owns a deep-level block of ground which may be of some value.

The **Day Dawn (P.C.)** is probably exhausted.

The position of **Mills' United** mine is more promising; and if an amalgamation between this and **Day Dawn Freeholds Consolidated** were effected, the two might make one payable mine. However, this would be deep—for the ground indicated lies at over 2000 ft. vertical—and one would first require evidence that the area of payable ground was really substantial.

On another line is the **Queen Cross**. The quantity of payable ore still in this mine is quite uncertain.

Two hundred miles north of Charters Towers is the Hodgkinson field. Very little work is now being done here. The same applies to the Palmer district.

In the Etheridge field small working syndicates keep up a moderate production of gold, in spite of a great scarcity of water. The mines here have been reported on, with a view to being equipped on a large scale, but the figures were not satisfactory.

At Croydon there is now not much of value being found. The English-owned mines there—such as **Rogers' Golden Gate**, and **Croydon Consols**—are at present not doing well.

Successful gold-dredging in Queensland is doubtful, as the river-bottoms are usually too rough.

South Australia. South Australia is the least important of the states as regards gold-mining, and its yield is little.

In the far interior there are two small gold-fields, Tarcoola and Arltunga. It is thought that the latter of these carries a good deal of low-grade ore. The drawbacks to cheap mining here, of which the most serious are lack of water and costly transport, preclude the idea of such ore being worked at a profit.

In the northern territories, to the back of Port Darwin, there is more or less gold-mining, which is mainly in the hands of Chinese. It is doubtful whether the deposits are of a permanent enough type to justify their exploitation by British companies. The

Northern Territories Company owns various small mines, but its future is uncertain.

South Australia to date has yielded less than £2,500,000 of gold.

Tasmania. The gold output of Tasmania is made up almost entirely from the Mount Lyell mine, where gold is produced as a minor product, and from the Tasmania and New Golden Gate gold-mines.

Various gold-fields have been started at one time or another in Tasmania—Lefroy, Mangana, Ringarooma, Mathinna, and Beaconsfield; but with the exception of one payable mine in each of the latter fields, nothing of value has been found.

The **Tasmania** is now owned by a London company. The mine was started in 1877, and, in the hands of local owners, yielded nearly £800,000 profit. The reef is of white quartz, its average width is seven feet, and at its best the pay-chute was 1500 ft. long. In the bottom it is shorter than this by some hundred feet, but there is no evidence to show that a rapid contraction of the chute will take place.

The **Tasmania** is the wettest quartz-mine in the world. It is due to that fact that it was sold to a London company. The local owners worked it to about 800 ft., but they then found that a large expenditure was required for new pumps, and as they were not prepared to face this, they sold the mine.

The new company started with very little ore in sight, and with the knowledge that before much more could be exposed an expenditure of £200,000 was required. A further problem was the immense flow of water which had to be faced, but it was assumed that the large expenditure would include the mastering of this, and the erection of such a pumping plant as would keep the water permanently in check.

On the other hand, there was the knowledge that this mine carried one of the finest ore-chutes in Australasia, that it had only been

exhausted to about 800 feet, and that in the lowest workings it still carried high values for over 1000 ft. in length.

The purchase of this mine, and its flotation in London, was justifiable. But the price paid to the local owners, who were running it at no profit, was excessive; while the nominal capital decided on, of £500,000, was out of proportion to the working capital provided. I consider that on a gross capital of £500,000, one-half should have been cash available for development. In the meantime, for lack of sufficient funds the company will go considerably into debt.

This financial question will take some years to adjust, for in addition to the main pumping scheme, and to the ordinary development of the mine, a new shaft has to be sunk, and a new sixty-stamp mill put up. Until all this is done and paid for, the profits of the mine, which will no doubt eventually be substantial, will not be available for distribution.

The work now being done includes the erection of perhaps the biggest individual pumping plant of any mine in the world. The flow of water in the mine is placed at 3,000,000 gallons in twenty-four hours. This pump has a normal capacity of lifting 6,500,000 gallons, and at high speed 8,000,000 gallons from 2000 ft. The margin of capacity ought to be sufficient to master the water, and one therefore assumes that in course of time, probably some time in 1906, the active development of the mine can be proceeded with.

At present the development is restricted, but the work done by the new company at the 900-foot level has been satisfactory: the width and values at that depth are maintained.

The eventual capacity of the mine, on an ore-chute of these dimensions, should be quite 12,000 tons a month, which would require 100 heavy stamps. On such an output there would presumably be a big profit. It will be some years before this stage is reached, however; and before that time a lot of money will have to be spent. In the meantime, owing to the small quantity of ore-reserves, no estimate of the mine's value can be made.

The **New Golden Gate** is a locally owned mine. At the time I inspected it, now some years ago, it was opened to 1400 ft. It had yielded 180,000 tons of ore, of a recovery value of about 70s. a ton, and had paid £300,000 profit.

The mine was then under offer to a London company for £400,000 in cash, which would have been a ridiculous price, as the profit then in sight did not figure up to £100,000. It is, however, at a price, a good mine.

The **Tasmanian Consols** owns the extension of this ore-body, and has opened up some pay-ore at between 1100 and 1300 ft. I do not think there is any material quantity of this. Adjoining this is the **Tasmanian Gold Estates**.

The **Mangana** has a big ore-body, but of poor value.

New Zealand. Gold was found in New Zealand in 1857, and that country has produced to date over £60,000,000 sterling. In 1904 the yield was £1,987,000. The gold-mining industry is falling back, however. Most of the mines are too small to earn profits, and discoveries do not keep pace with abandonments.

In 1896 and 1897 a large number of English companies were floated. Few of these have survived, and almost none have done any good. The local quartz-mining industry is also reduced to a small scale.

As against the comparative failure of quartz-mining is to be set the successful gold-dredging in the Otago and west-coast districts of the South Island. Some hundreds of dredges are at work in different localities, and have in many cases been successful ventures.

This industry is not capable of indefinite expansion. Probably all the dredging ground is now known, and it is thought that fifteen, or at the outside twenty years will exhaust this. The present years probably mark the zenith of the industry. In 1904 about £470,000 was recovered by the dredges.

There is not much quartz-mining in the South Island. Several small mines exist in Otago.

At Reefton, on the west coast, are the mines belonging to the **Consolidated Goldfields of New Zealand**. These are the Welcome, Wealth of Nations, and Golden Fleece. They have been earning small profits for some years, but are essentially small mines.

The **Progress** mine is a well equipped and handled property. It has earned profits for a number of years. The present crushing capacity is nearly 60,000 tons a year, and a recent report shows ore-reserves for about 2·5 years ahead.

The future of the mine is hardly enough assured to attempt any valuation of the shares.

The **Golden Blocks (Taitapu)** and **Taitapu Estates** have a little payable ore exposed.

In the North Island one is in a volcanic country. The whole of the island is of a more or less soft formation, and appears to be continually moving. A drive along a level will not stand without timbering. This timber, too, has to be renewed frequently, and the track relaid.

The characteristics of the ore are equally treacherous, and nearly all the mines are now shut down. On the Coromandel field, where rich stringers were worked in earlier days, all the English-owned mines are either now liquidated, or let on tribute.

On the Thames field, which had once a great history, the same state of affairs exists. The English-owned mines are all failures, and closed down.

The Ohinemuri field, lying thirty miles to the south, is the most important quartz-mining field in New Zealand.

Here is located the **Waihi** mine, which has already produced over £4,000,000 sterling; in 1904 the output was £683,000.

This mine is now developed to the 700-foot level. At that point the values do not seem quite so good as at shallower levels, nor I imagine will the length of pay-ore be so great; on the other hand,

there is no reason to think that the mine will not continue to be highly profitable to a still greater depth.

There is a marked trend of the ore-chutes to the north, and in time, if these live to such a depth, they may be expected to pass into the ground of the Waihi Grand Junction; but between the present bottom of the Waihi, and the point where they might pass out, there would be enough ore—assuming it payable—to last for many years.

The present reserves, including no ore below the 600-foot level, are reported to be 712,000 short tons; or say over two-and-a-half years' work.

The ore is somewhat refractory, and the amount of silver present is against a good extraction. At present, on ore assaying about 64s. a ton, there is a loss in treatment of 12s. a ton. It is hoped that finer grinding may improve the extraction, and ball-mills are being put in.

A valuation of Waihi shows—

(a) Profit in ore-reserves, say	.	£1,050,000
(b) Cash, etc.	.	200,000
Total	.	£1,250,000

With the shares at £6 $\frac{3}{4}$, the market valuation is about £3,348,000, and the profit in sight is therefore equal to 39 per cent of the market valuation. This is, of course, too big a discrepancy; which would soon make itself apparent if the mine began to show poorly in the bottom.

This is one of the best of gold-mines; but to-day, with over £4,000,000 taken out of it, is certainly less valuable potentially than a few years ago. The mine is at present over-valued.

The **Waihi Grand Junction** has two leases, and owns the extension of each end of Waihi. The northern lease is thought to carry the continuation of the main Waihi chutes, which are estimated to enter its ground at a depth of something over 1000 ft.

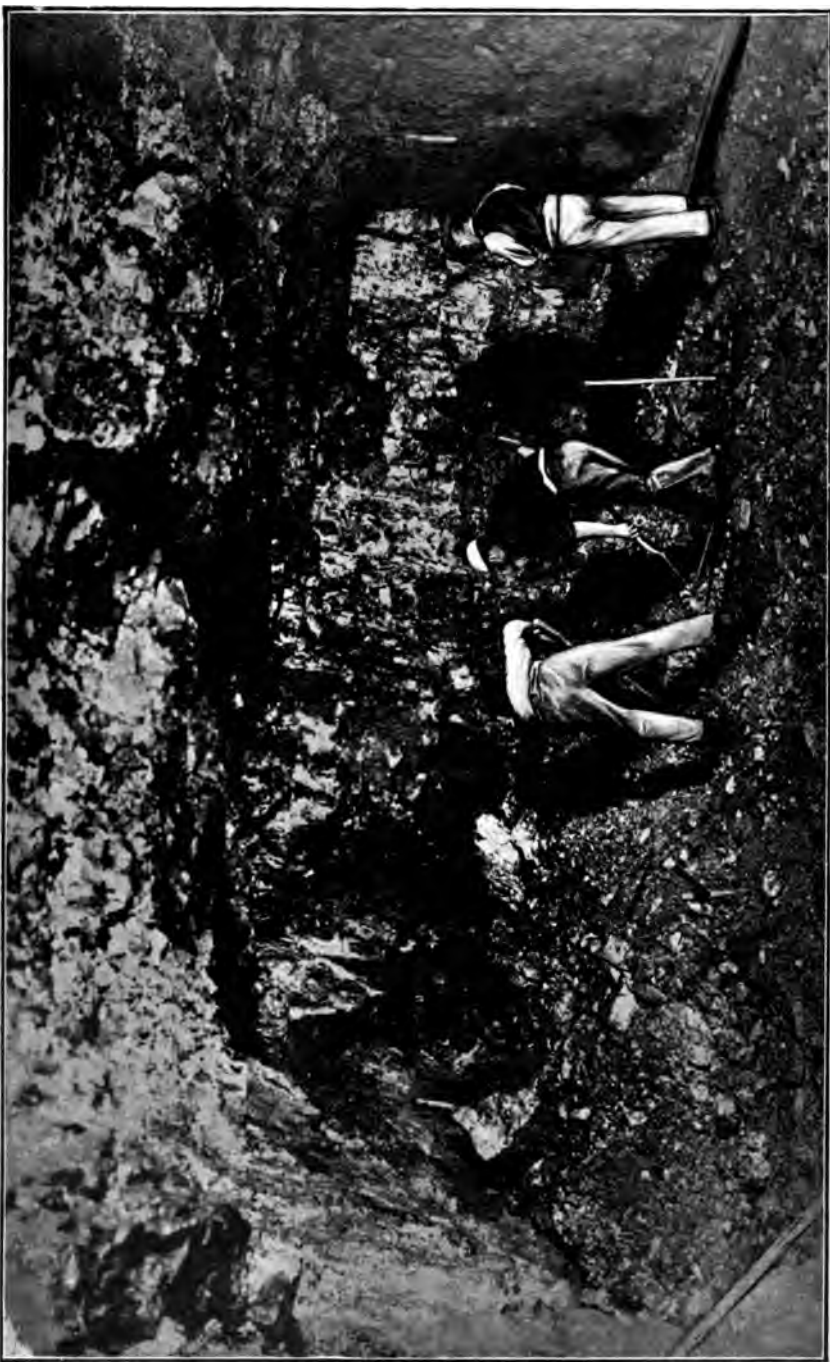
With a view of proving this, the Waihi Grand Junction put down

a borehole and at over 1000 ft. cut a big body of quartz, sections of which showed good values. Taking note of this, and of the fact that the Waihi ore-chutes are most certainly dipping in this direction, the inference is that this deep ground will one day be very valuable. Work is at present centred in opening up the reef at shallower levels, at 500 ft., and in winzes below that point. Good ore is being found, but it is narrow. I do not think the mine will be greatly productive from the upper levels, and believe that the real future is rather below than above 1000 ft.

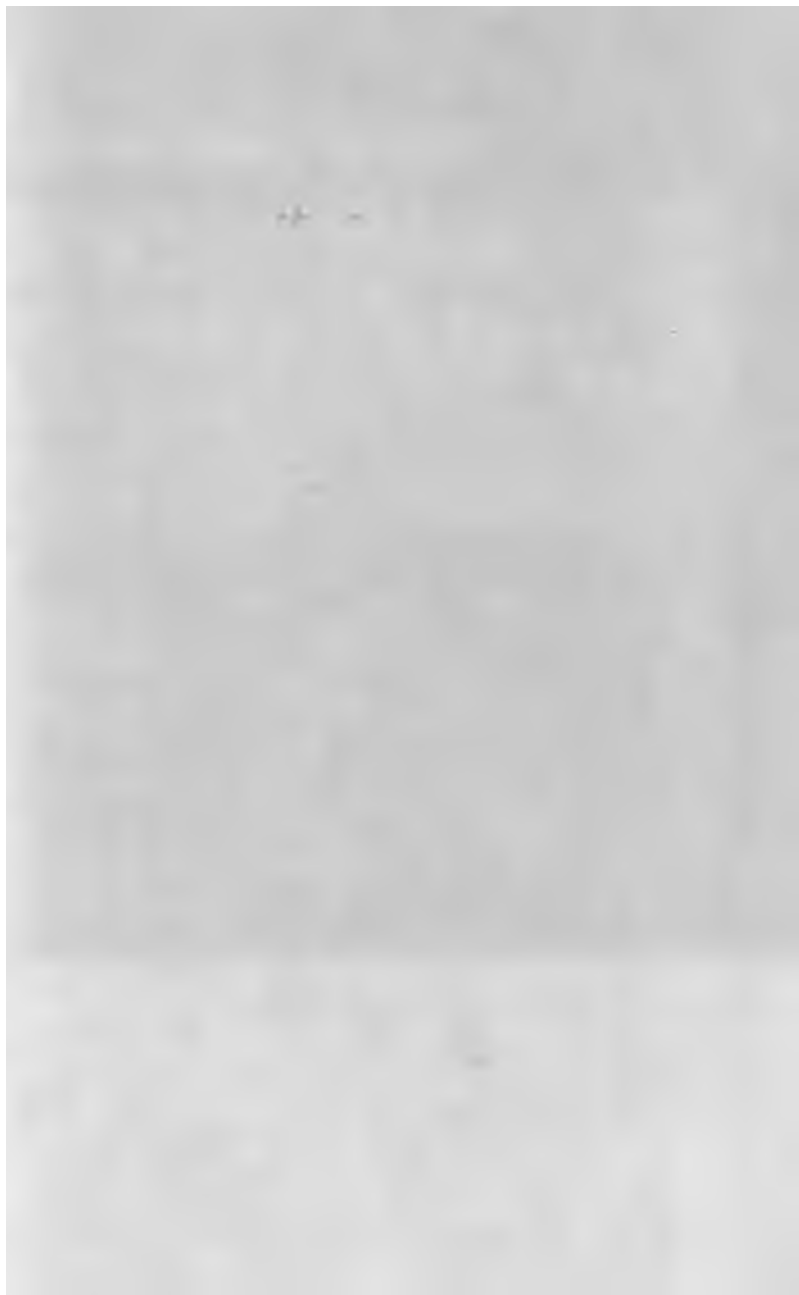
Considering the big quantity of water to be handled on this field, economic mining demands one central pumping plant. For this, and many other reasons, I strongly advocate an amalgamation of these two mines. If one pumping plant, such as that now installed at Waihi, is sufficient to handle the water of the district, it would be a needless waste of a large sum of money to put in another plant in Grand Junction. This, however, will have to be done if that mine is to quickly reach its best ore, and to justify anything like its present valuation.

Each mine would gain much by amalgamation. The Waihi is over-valued at present. On the top of that, there is the risk either of the ore-chutes dipping into Grand Junction at a few levels below the present bottom of the mine, or the risk of the ore getting poorer in depth; and in an ore of this nature, where a good deal of calcite is present, that is an eventuality not to be overlooked.

The Grand Junction, too, would gain a great deal. It would be saved the expenditure of a sum which, first and last, before it can produce on a scale commensurate with its capitalization, I figure at £250,000. Then, too, the shareholders would be in immediate receipt of substantial dividends, which otherwise they may not receive for a number of years. It has also to be noted that the value of this mine in depth is not yet assured. One borehole does not prove value in a big ore-body. To sum up this question, I would say that neither mine is in a strong enough position to dictate its own terms, but that each has much to gain from an amalgamation on a reasonable basis.



STOPE IN WAIHI MINE



In this district is the **Talisman**, which is now making some profit. There is a considerable amount of ore in sight, but as the adjoining mines have become poor in depth, one cannot describe its future as assured.

The **New Zealand Crown** mine has become poor in depth.

The **Komata Reefs** is a small mine, but is making some profit at present.

British New Guinea. There has been little progress here for some years. The climate is bad, and there have been no discoveries of quartz yet.

On Woodlark Island, off the coast, the **Woodlark Proprietary** is turning out a little gold ; but this island has not come up to expectations.

CHAPTER XI

THE GOLD-MINES OF THE EAST

India. The principal gold-mines in India are situated in the Kolar district of the state of Mysore. The boundary line of the Madras Presidency is only a mile or two distant, and the most southerly mine of the group, lying apart from the rest, is situated in Madras. The mines are connected by a short branch with the Madras-Bangalore line, and can be reached by rail from either Bombay in forty hours, Madras in twelve hours, or Tutecorin in thirty hours. The country surrounding the mines, which lies at an elevation of 2800 ft., possesses few features of interest; the blue outlines of mountain ranges are visible in the distance, but the near neighbourhood shows only an undulating, uncultivated tree-dotted expanse, in contrast to the luxuriant foliage and well-tilled paddy-fields of the lower-lying ground of Southern India. The climate is fairly healthy.

The geology of this gold-field may one day become a subject of great importance.

The formation in which the reefs occur is a schistose band. Authorities place the length of this at forty miles, but over more than half the distance there has never been evidence of payable gold. The width of the band from east to west varies in the central section between one and four miles, but towards the extremities it becomes narrower and finally tapers out. This schistose band is surrounded on all sides by granite, in which no values are found. The main feature of interest, geologically, is that the schists in which all the reefs occur, are folded over into a syncline. This

is beyond doubt, as the dip of the strata across any section of the belt will verify.

What, then, is the effect of this fold to be on the reefs? If they are true fissures, of later origin than the schists, the fold will not affect their course in depth. On the other hand, if they are stratified bands, lying parallel with the schists, will they not be subjected to its folding? And will not their persistence beyond the syncline be a matter of doubt?

Geologists are divided over this question. When I inspected these mines, my opinion was that these were fissure-lodes. Later evidence leaves me doubtful. On one point I am certain. Where there is cause for doubt as to the future of a mine—and in this case there is more or less doubt—the owners of that mine should take steps to cover their risk. This they have failed to do so far. The discrepancy between the market valuation and the profit in sight in these Mysore mines is out of all proportion. If the mines were to live with certainty to 4000 ft. vertical, and to maintain their present values and widths, even then the present market values would hardly be justified. If, from the point of view of geology, the owners of these mines ought to exercise caution, from that of mine-valuation they should learn still greater caution.

The reefs of the Kolar field are :—

- (1) The “Champion” lode, on which the richest mines are located. This holds its course with regularity through the main section of the field; is about 4 ft. wide on an average, dips at about fifty degrees, and still, at a depth of, in one case, 3000 ft. on the incline, and in others over 2000 ft., carries high values.

There are branch sections of this lode in places. These are sometimes of good value, but are irregular.

The mines on the “Champion” lode are the Mysore, Champion Reef, Ooregum, and part of the Nundydroog. On the branches are part of the Nundydroog, Tank Block, Coromandel, and Balaghât.

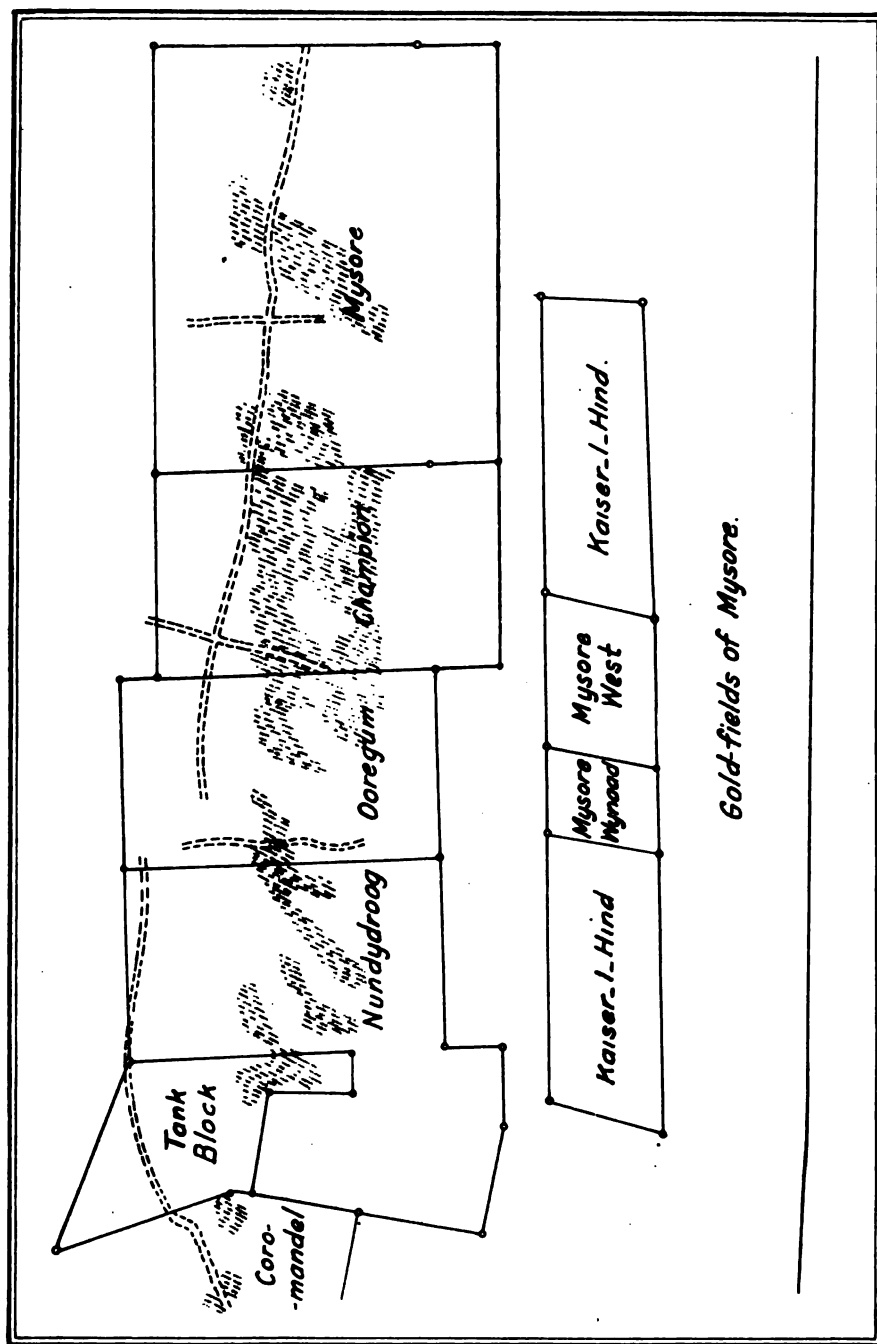
- (2) The west or "Oriental" line of reefs. These lie 3000 ft. west of the "Champion" line. They have been worked by several companies, but as yet with no success.

On this line of reef are the Oriental (now part of Nundydroog) Goldfields of Mysore, Nine Reefs, and Road Block.

On the Champion lode the ore occurs in well-defined chutes. Usually these chutes have a clear dip to the north. The consequence of this is that a chute of ore found near the north boundary of one mine benefits the adjoining mine more than that in which it originates. The Champion Reef mine in this respect has benefited from the Mysore ore-chutes; the Ooregum from Champion Reef; Nundydroog from Ooregum; and so on.

As a rule, the biggest ore-chutes have held well in depth; but not always. Several that were big in area, and of good value, in the upper levels of Ooregum and Nundydroog, have pinched out as depth was reached. On the Mysore and Champion there has been some falling-off in the average values of the ore-chutes, but they are still, in the lowest points of each mine, almost as sound as they have been at any time.

The commencement of modern mining in the Kolar district, which dates from about 1880, was due to the discovery of ancient workings, many of which can still be inspected. The ancients prospected about on the surface outcrops till they came upon a chute of rich ore. This they would work out, with their rude appliances, actually to a depth of 150 ft. or 200 ft. The method employed was evidently to heat the ore by means of a fire, and then to throw cold water upon it. After this it was rendered more friable, and could be worn away by being hammered with pieces of a harder rock. More strange than this must have been the methods used for getting rid of the big flow of water that would be encountered in depth, and especially for keeping the water away from the fires. Large gangs of workmen must have been employed to continually bale and pass up vessels of water to the surface. As if to bear out this, I saw an



CENTRAL SECTION OF KOLAR FIELD SHOWING CHUTES OF PAY ORE.

old working in the Coromandel mine in which were the remains of hundreds of old vessels for carrying water, while series of niches, evidently to hold the feet of the workmen who were baling and passing up the water, were cut in the footwalls.

As to the general conduct of mining on this field, I have a favourable opinion. Whether these mines are individually, successful or not, each is at least a legitimately carried out and honest mining venture. If shareholders choose to over-value the mines, and to assume that this small area of ground, which has already produced about £20,000,000 sterling, must necessarily last for ever, it is largely their own fault. All the results of developments, with assays and widths of ore, are published regularly, and the shareholders are in a position, once having got plans of the mines, to keep them up to date, and to keep in close touch with the ore-reserves. If those who control the mines would agree to use the 2000-lb. ton, and to abolish troy weights, speaking of values in pounds, shillings, and pence, instead of in ounces, pennyweights, and grains, it would assist in reducing things to system. Other mines are gradually falling into line in this respect. I wish the Indian mines would follow suit.

White labour is not a heavy item; there are few whites underground, and these are mostly Italians, who go out on contract at from £6 to £8 a month.

Black labour, at the first glance, seems to be cheap. The average native receives from 5d. to 8d. a day, and natives at about this rate of wage are employed to work rock-drills, to blast, to drive engines, and, generally, to do all sorts of work that in other gold-mining countries could only be entrusted to white men. All stoping is let by the fathom to native contractors, so that the responsibility of a regular supply of labour falls more on the contractors than on the company; there is no scarcity of native labour, however. With all this, native underground labour is not cheap. The rock-drill men show no ability to save dynamite, the ordinary hammer or

stope native does not get through half the work of a Rand Kaffir, while one and all need the closest supervision, or they would not work at all.

Timber has to be used in quantities in all the mines, and is an expensive item. It is brought from Calicut, on the west coast, some of it, especially the teak wood, being among the hardest of all timbers.

Coal is, relatively, the heaviest item, and its cost probably ranges from 3s. to 7s. per ton of ore milled. Bengal, Hyderabad, Australian, and English coals have been tried, costing from about 24s. to 35s. per ton delivered. Of these, the Hyderabad coal works out cheapest. The electric-power installation on the Cauvery River, run by the Government of Mysore, has, however, in the last year or two considerably reduced the use of coal, and the expenditure for power. Dynamite, owing to the great hardness of the rock, and to the want of skill of the native workman, is a moderately heavy item. All the mines are supplied under one contract. The contract price is, or was, about 70s. a case for dynamite; for gelignite it is correspondingly less. The average cost, per ton milled, works out at under 3s. The scarcity of the water supply is serious at times. Several of the larger mines, notably the Mysore and Champion Reef, have at times barely enough water to keep their stamps at work.

Cyanide treatment is cheap. Tailings can be screened, filled into tanks, and emptied, for 4d. per ton. The extractions are fairly good. Slimes and residues, which assay only 2 dwts. or less, are treated at a profit. To secure good cyanide extractions, it is necessary to use a screen in the battery of at least 1200 mesh.

The mines of the Kolar field, lying as they do in the State of Mysore, come under the government of that state. The ground on which the mines are is part of the area of a concession granted by the Mysore Government to certain parties about 1881. The royalty to the Mysore Government from this concession was fixed at 5 per cent of the gross yield, and the period of the concession

for thirty years ; it will, therefore, be seen that the leases of all the mines on the Kolar field have only six years to run. At present, the royalty paid yearly to the Mysore Government from the Kolar mines is over £100,000, besides large indirect receipts from railways and from the subsidiary industries that gold-mining has brought into existence. It has been officially notified that the leases will be renewed for a further thirty years. The terms to be imposed by the Government for the new leases are to be 5 per cent of gross yield as before, plus an extra $2\frac{1}{2}$ per cent on dividends.

STATEMENT SHOWING THE TONNAGE CRUSHED, YIELD OF GOLD, AND WORKING COSTS PER TON OF 2240 LB.—EXCLUSIVE OF ROYALTY—OF THE FOUR PRINCIPAL INDIAN MINES, OVER THREE DIFFERENT PERIODS.

		NAME OF MINE.			
		Mysore.	Champion Reef.	Ooregum.	Nundydroog.
For Years 1896-7 .	Tons crushed .	64,297	87,772	63,888	39,490
	Yield per ton .	132/4	102/3	77/-	85/1
	Cost per ton .	41/9	37/1	41/-	33/7
For Years 1900-1 .	Tons crushed .	116,576	112,540	74,867	37,460
	Yield per ton .	108/7	107/3	83/5	97/5
	Cost per ton .	34/8	43/1	41/10	45/7
For Years 1903-4 .	Tons crushed .	191,000	181,948	127,449	75,840
	Yield per ton .	82/5	89/10	43/5	68/-
	Cost per ton .	32/1	35/8	26/10	34/3

The **Mysore** mine is developed, on its principal ore-chute, to over 3000 ft. on the incline. At that depth the size and value show, so far as I can see, no material falling off. This main chute is now proved to be one of the most persistent yet discovered in any quartz-mine. It is sometimes humorously remarked by those who have had much experience of ore-chutes that "Mysore is a fluke," meaning to infer that such persistence of value in depth is contrary to

nearly all experience. Turning to the north end of the mine, it is to be noted that a large and rich ore-body has made in the lower workings from Tennent's shaft, which is spreading out in width towards the Champion Reef boundary. On this boundary, at some hundred feet lower than the present Mysore workings, the Champion Reef has exposed good ore; and the inference is that there is a large area of yet unexposed ore of good value in this part of the Mysore.

The present reserves in the mine are placed at 520,000 tons. The reckoning is conservative, however, and, no doubt, the figure is nearer 600,000 tons, or say three years' work. The extraction is given as 85·8 per cent. This seems low. Would not fine grinding, by bringing the extraction up to, say, 92 per cent, justify itself financially?

As I have said, the mine is looking exceedingly well at present, and, in the north end particularly, may even improve. But consider. The more gold taken out of a mine leaves less for the future; and in the face of a gradual exhaustion of gold and an increasing depth from which it has to be taken, is a rising, or even a stationary value for such property, sound finance?

There is ore in sight for three years. But to pay off the present value of the mine, and to pay likewise current interest at not less than 6 or 7 per cent on the millions invested, would require about fifteen years' ore. Assuming a slight falling-off in value, it will require something like 3,000,000 tons of ore to redeem the capital and pay interest. In other words, the mine, which is already one of the deepest gold-mines in the world, is being depended on to last to a stupendous depth.

It may last to such a depth—syncline or no syncline—but its owners, in capitalizing it as they do, are taking an unjustifiable risk.

At the present market valuation of £6 17s. 6d. there is, including cash, 40 per cent profit in sight.

Champion Reef is now developed to below 2000 ft. on the incline. There is a remarkable concentration of ore-chutes in this property,

and at about 2000 ft. deep there is payable ore practically from one end of the mine to the other.

The inference from this is that the mine is likely to continue of good value to a considerable depth below this point, and the developments for years to come ought to be good.

The present ore-reserves are figured at 420,000 tons, and the estimate being conservative, it is safe to say there are 500,000 tons, or rather less than three years' work.

The position of this mine is rather more favourable than Mysore, in that it is not exhausted to such a depth. The ore, too, is of rather better value, while the general appearance of the lowest workings is better than in Mysore. The market valuation is also substantially less.

But judged from the point of view of sound mine-valuation, taking note of the present depth of the mine, of the large capital, of the relatively small ore-reserves, and of the depth to which good ore will have to continue to pay off the capital invested, I consider the mine is over-valued.

At the present price of £1 15s. the profit in sight, including cash, is 40 per cent.

Ooregum. The original pay-chutes gave out at a relatively shallow depth; and from, say, 1000 ft. deep the mine has continued to exist in somewhat of a hand-to-mouth state, never having large ore-reserves.

Most of the ore mined below 1200 ft. has dipped in from the Champion Reef, which adjoins on the south. Theoretically, as the ore-chutes have usually a marked northern dip, this good ore should, by this time, at a depth of over 2000 ft., be found to have dipped half-way across the Ooregum. It has, however, not done so, and a more or less vertical strip of good ore next the Champion Reef boundary is, up to the present, all that has come in.

The ore-reserves are now small, and if present conditions continue, some of the stamps will have to be shut down. On the other hand, there is always the chance that the pay-ore will resume its normal

dip to the north, in which case the lower levels of the mine might become highly productive. In this case the deep-level area belonging to the Goldfields of Mysore Company, as in the case of the Mysore and Champion Reef, would be acquired.

The future is, however, problematical.

With the shares at £1 there is at present profit in sight equal to 18 per cent of the market valuation.

Nundydroog works two reefs, or rather, the main lode and a branch lode. The ore-chute worked on the main lode dips across the property at a flat angle, and with a view of protecting the extension of this, the company has acted wisely in buying the Oriental property. Should the dip of the chute become steeper, there is also the natural deep-level ground, which can be secured from the Goldfields of Mysore.

In the north end of the mine, on the branch or Kennedy's lode, the ore-chute went wrong, and the prospects for that section of the mine were poor. Recently, in the bottom there has been an improvement, and it is possible that the chute may again come into being. This sort of thing does happen on the Kolar fields. Elsewhere it is of such rare occurrence as to cause secret surprise to the management. Here it is taken as a matter of course.

The last estimate of reserves gave 65,000 tons, less than one year's work. The reserve must be much larger than this, and the prospects of both sections of the mine more assured to make the shares a justifiable venture at a premium.

With the shares at £1 10s. there is at present a profit in sight equal to 18 per cent of market valuation.

The **Goldfields of Mysore** Company still retains the immediate dip ground of Ooregum and Nundydroog, also various other deep blocks on this Kolar field. The company is interested also in mines in the Sudan.

The **Mysore West** and **Mysore Wynaad** jointly work the Tank Block mine, adjoining Nundydroog. This is a small property only,



MYSORE MINE—NATIVES WORKING IN A STOPE

but is at present earning a little profit. Each mine also owns a deep-level block on the dip of Champion Reef and Ooregum. That belonging to the Mysore West is the larger and better located area.

The **Coromandel** mine has lost the good ore-chute that existed in the upper levels. It is in a doubtful state.

Balaghât is a good small mine. Its ore-reserve of 40,000 tons is not sufficient to include it among the more solid mines of the field. On a small and not assured scale its present prospects are good.

Amongst the disappointments of the Kolar field are—at least, so far as is known at present—**Nine Reefs, Road Block, and New Kempinkote.**

Of other localities in India where gold is found, interest has lately centred on the Dharwar field, in the south of the Bombay Presidency.

Very considerable ancient workings exist here, and some good ore has been exposed; though it is early yet to assume that the field will be a success. Here are located the **Dharwar Gold Mines, Dharwar Reefs, Goldfields of Dharwar, and Sangli.** These are under the same management as the Mysore mines.

The **Hutti** mine at Raichore has thirty stamps, and is making profits. The ore reserves are figured at 30,000 tons.

The **Indian Mines Development Syndicate** is developing a mine in Bellara, Mysore.

The **Kadur Mysore** is shut down.

In **Burmah** there is no gold produced from quartz-mines. On the Irrawaddy River a prospecting dredge has been at work for some time, and it is thought that large areas on this river will be profitable to work. The value is not high, but the gold is evenly distributed, and facilities are good.

Thibet, in spite of rumours of great richness in gold, is a country whose mineral value is not easily apparent. The geologist who accompanied the recent British Expedition to Lhasa made this clear.

The **Malay Peninsula**. The southern part of the Malay Peninsula consists of the states of Perak, Selangor, Pahang, Negri Sembilan, and Johore. These states produce among them about one-half of the world's output of tin; but it is only in Pahang so far that gold has been worked to any extent.

To the north of these, but not under British control, is the state of Kelantan. Here the **Kelantan Gold-dredging Company** is at work and has produced some gold. Its concession is reported to be for 5.5 miles along the Kelantan River. For such a relatively small area the capital of £180,000 is much too high. There is not much dredging-ground that will stand a capitalization of over £20,000 per dredge. It is proposed to run three dredges in this area, so that from an economic point of view the capital, including expenditure on purchase of the ground and payment and erection of dredges, should more fittingly stand at £60,000.

On the concession of the **Duff Development Company** a gold, silver, and lead ore-deposit is being opened up.

The climate of Kelantan is unhealthy.

When gold-mining started in Pahang, about fifteen years ago, prospectors who came there from Australia were impressed with the size and extent of the old-workings along several of the lines of reefs. One place I saw, where part of a hill carrying alluvial gold, over a hundred feet high and several hundred feet long, had been mined away.

These workings are not "ancient" as are those in Rhodesia, India, or the Sudan. They are thought to be less than one hundred years old, and their origin, like most other work in this part of the world, may be traced to the Chinese.

The first mines floated were **Silensing, Punjom, and Raub**. These were large concessions, embracing numerous old workings, and to

the continued exploitation of these old workings in depth all subsequent work has been confined.

The results have not been good. In each mine payable patches were met with near the surface, but these patches did not live to any depth. Silensing and Punjom are now shut down.

Raub has a considerable equipment, and its plant is driven by electricity, generated by water power. In earlier years one of its mines, Bukit Koman, yielded a biggish amount of good ore, and dividends were paid for some time. Below 150 or 200 ft. values fell off seriously, and for some years the mine has been running at a bare profit. The smaller ore-chutes on the concession have proved disappointing, but some of the ground has not yet been fully prospected.

About forty miles north of Raub are the **Kechau** and **North Kechau**. These are small mines, but when I inspected them there was some payable ore exposed.

In the states of Perak, Selangor, Negri Sembilan, and Johore, there is no gold-mining to speak of.

The characteristic of gold-mines in the Malay States has so far been that they lose their value at shallow depths. It does not follow that there may not yet be undiscovered ore-chutes which will prove to be more lasting; but I am justified in saying that no mine there should be floated until it has been developed and proved of value to at least 300 ft.

In the **Dutch East Indies** there is gold-mining in Sumatra and the Celebes.

A notable gold-mine is the **Redjang Lebong** in Sumatra, with a very large lode of good value. It is held by Dutch owners. The ore-reserves at the end of 1904 were estimated at 182,000 tons, worth about £3 10s. a ton.

The directors of this mine, in Batavia, are elected for a ten-yearly period, and are entitled to a considerable percentage on the profits—which reminds one of the old rhyme.

The **Lebong Soelit** mine in this neighbourhood is reported to be valuable, and there are other promising localities in Sumatra. The climate is bad.

In the Celebes there are several small producing mines. The **Totok** is said to be the best of these.

Borneo. In the Dutch section of Borneo several small mines are producing. There is said to be good dredging-ground here.

The **British North Borneo Company** is doing some interesting gold-mining. This consists of quarrying a big deposit of breccia, which, after superficial crushing, is treated direct by cyanide. The average yield is less than £1 a ton.

The company's gold production in 1904 is given at about £180,000.

China. The yearly output of China is at present supposed to be about 1·5 million sterling, but no exact estimate is possible. There are no British-owned gold-mines in the country. This is not entirely because of political reasons, but because, rather, there are no good mines to be got. The output of gold comes mostly from many small producers in Northern China, and there is no such thing as a large producing mine equipped with machinery. An American engineer, retained for some years by the Chinese Government to report on the prospect of metal-mining, told me that in the districts west and north-west from Peking he had inspected the remains of some hundreds of old gold-mines worked to water-level and abandoned. Of these there were, I think, two that appeared to be of sufficient area to be worth re-prospecting; but not a single mine did he see that could be really called a mine.

There is one known big gold-mine in China, although as yet it has only been worked in the primitive native way. It is the **Choa-Yuen** (mountain of gold), about forty miles distant from Chefoo. Some years ago, when sampled, there was ore exposed to the amount of nearly 200,000 tons, worth over £2 a ton. So far, those

who have endeavoured to buy this mine from its Chinese owners have found that their united consent and a clear title are hard things to procure.

In the British settlement at Wei-Hai-Wei, not far from this, a Shanghai company started a mine and erected a mill. I believe it is of small value.

In Manchuria and Mongolia, especially through Russian sources, one hears rumours of rich gold-mines. When in Manchuria I traced some of these rumours to their source, with the expected result that there are really no mines there yet. A credulous Russian company sent up much machinery some years ago to Urga, in Mongolia. But it turned out that there was no mine after all, and the machinery remains in its cases. In Manchuria, before the war, one or two small mines were being developed by Russian capital, including one within a few miles of Port Arthur, but there is no reason to regard these as of much value. No doubt, in such an immense territory there are many potential mines, but they have not yet discovered themselves to Europeans.

Japan. This country is singularly poor in gold-mines, so far as is known. As yet there are no foreign-owned gold-mines, and it is surmised that if any good things should be discovered, the Japanese are astute enough to keep and work these as they have done with their copper.

On the Island of Formosa the yield of gold is increasing, that for 1904 being reported as £180,000. This comes mostly from three locally owned mines. A good deal of prospecting is in progress.

Korea. This country is beginning to rank as an important producer of gold; in 1904 the yield was over £500,000. Besides a considerable native industry in gold-mining, several concessions were given off a few years ago to Europeans. There was a British, a German, and an American concession. The two first-named have

not materialized, but the American concession, floated as the **Oriental Consolidated Company**, with headquarters in New York, has become a powerful and valuable concern.

Under the original terms of concession a royalty of 25 per cent of profits is due to the King. The Oriental Company in good time compounded this for a fixed yearly payment of about £2500. This figures out, on the present scale of working, at 3½d. a ton, whereas had no such agreement been made the payment would be about 2s. 6d. a ton.

There are a number of mines worked on the concession, and at present there are five different mills, with 200 stamps in all. In addition to mining its own ore, the company buys ore from a number of natives, who work smaller mines on tribute. In this way, besides making a good profit on such ore, the company gets its concession thoroughly prospected. The reefs are of quartz, in granite. They are low grade, but several of the deposits are of big extent. The permanence of these big deposits seems assured for a number of years.

At a recent date the ore-reserves were estimated at 1,091,802 tons. The gross value of this ore is placed at 23s. 11d. a ton, and the net profit at about 10s.

In 1904, owing to the scarcity of labour, due to the war, working costs rose above the average. In 1903, on a production of about 200,000 tons, these were the figures :—

Tons of ore mined and milled . . .	198,410
	s. d.
Costs.—Mining and development . . .	4 2·5
Transportation . . .	0 1
Milling . . .	2 1
Treatment of concentrates . . .	1 0
Sundry . . .	1 10·5
Total costs	9 3

The ore is free milling ; concentrates are saved and treated by cyanide. The extraction is about 80 per cent.



A MILL OF THE ORIENTAL CONSOLIDATED COMPANY, KOREA

The weak spot in the working costs is the milling. Speaking relatively, 2s. 1d. is a high figure for this. It is due to the necessary decentralization of the plant into five different mills, some of which are twenty miles distant from the centre. A scheme is under way for bringing in water power and running the plants with electricity, which will effect some saving. It seems probable that the number of stamps will eventually be increased.

It is interesting to compare the work done by the directors of this Company, who are experts, with that done by the directors of Redjang Lebong—the other big gold-mine in the Far East. The cost of the head office of the Oriental Company in New York, including directors' fees, secretary, and office rent, was, for 1903, just one halfpenny a ton. I commend the reports of this company for their lucidity, both as to the accounts and the ore-reserves, to the study of mining directors in London.

The Oriental Company has a substantial reserve in cash and supplies. Including this, together with the net profit in sight in the ore, there is a total profit in sight of, say, £740,000. With the shares at \$17, this is equal to 50 per cent of the market valuation.

CHAPTER XII

THE GOLD-MINES OF RUSSIA AND SIBERIA

IN St. Petersburg, on my return from Siberia, I asked a Russian friend if he could get some information I wanted from the Mines Department. Next day he said he had arranged an interview for me with the head official of the department, a man of almost Ministerial rank, but said that I should have to wear evening dress for the interview. This I promptly refused to do. My friend said to me, "Why do you say that? You know it is the custom in this country when one calls on a high official." I replied to him, "I will tell you why; your official will receive me politely, and will talk profusely; but he won't give me any real information. His business is to receive, not to impart, information; and I feel sure that he will not care to tell me the things I really want to know. I happen to have a sense of the ludicrous, and the idea of putting on evening dress on a bitterly cold morning to go and interview a person who will not tell you what you want to know does not appeal to me."

I eventually compromised on a frock coat, and after waiting an hour in an ante-room we were ushered into the presence of the head of the Mines Office. I found him a most polite man, as all Russians are. But it was just as I had thought. I wanted to get some definite replies about certain phases of the gold-mining industry, and he could not, or did not care, to give me definite replies. When the subject of dredging was mentioned, he talked hazily about an immensely prosperous industry springing up, but could not give me the precise yields or figures from a single dredge. He knew no actual figures about the few quartz-mines in the

Empire, or their precise locations. Finally, he referred to his staff for the figures of the gross output of gold in recent years, and I found even then that only the bullion figures were known to the department.

I have mentioned this incident, for it illustrates rather clearly the whole position of gold-mining in Russia. What I have to say about mining in that country must not be taken by Russians as being unfriendly; indeed, I received the greatest kindness from their hands, and am not ungrateful; but it has to be recorded that as regards their gold-mining industry—government, mining engineers, and mine-owners—their methods are indirect and unpractical, and they must set-to and reform the whole business. If I did not think there was a big chance for gold-mining in Russia, or, rather, in Siberia, I would not take the trouble to proffer advice.

The production of gold in the Russian Empire is now about £4,300,000 a year, and has not varied much for many years past. The Government returns are given in bullion, and one has to arrive at the approximate figures by guesswork.

The figures of recent years are :—

PRODUCTION (IN POODS)¹

	1899	1900	1901	1902
General production .	2182	2185	2221	1924
From Imperial Cabinet .	<u>164</u>	<u>164</u>	<u>157</u>	<u>150</u>
Total poods .	2346	2349	2378	2074

No separate account is kept of the production of European Russia, but it is very small. It is also to be noted that less than 10 per cent of the total comes from quartz-mines. The alluvial mines

¹ A pood is equal to 43·88 lb. troy. If the average value of the bullion is 75s. per ounce, this would give the pood a value of £1974. In 1902 there were 1119 producers, either companies, syndicates, or individuals. Of these 42 produced 10 poods or over, and 2 produced over 100 poods.

of Siberia therefore give nearly the whole output of the Russian Empire.

Siberia has produced large quantities of gold for 130 years. Most of this came from the alluvial areas of the Urals and the districts nearest Russia. The richest of these areas are now exhausted, and the future alluvial production will come mainly from Olekminsk and the Trans-Baikal territories. To-day the Olekminsk, Amur, Tomsk, and Primorski districts give the largest yields.

The biggest individual producer in Siberia at present is the **Lensky** Gold Mining Company of St. Petersburg, working alluvial areas on the Lena river system, in the Olekminsk district. This company illustrates the unpractical way they handle mines in Russia. It is the show-mine of the country, so to speak, and is producing 160 poods a year. But year after year it has worked at a loss. The state bank, or, in other words, the Government, keeps advancing money to the company, and is now a creditor for no less a sum than £800,000. All that those who control the mine can urge in its favour is that in a few years more, with a better water-supply, it will be self-supporting, and may even earn profit. But why in the meantime have they gone on working, and run up this huge debt? A government that in this paternal way comes to the assistance of such a rashly conducted concern must be badly advised by its mining experts, and it goes to confirm what I said about theoretical and bureaucratic methods having usurped the place of practical common sense.

Do the Imperial mines pay?

The yearly yield of 150 poods, or thereabouts, to the Private Cabinet of the Czar, comes from many different districts where he owns property, chiefly from Nerchinsk; but I don't suppose it represents any net profit. In the old days these mines no doubt paid well; but the richest areas are now exhausted, and I conceive



A GRAVEL MINE IN SIBERIA



that the tributors and others who now furnish the gold make but a bare living and pay little royalty.

Alluvial mining, at the best, is not an exact science, and these Siberian mines have been no exception to the rule. The Russians have been so often disappointed in their gold-mines that they view the industry with indifference, and as yet have made no effort to put it on a sound basis. The average engineer is trained to look to coal or iron mines rather than gold mines to yield him a living, and it seems to me that few trained men in Russia have brought either brains or energy to bear on the problems which the alluvial mines present. As regards quartz-mines, they make no pretence of understanding their possibilities or developing them. No capital is available for that section of the industry; and yet Russia and Siberia must have the same proportion of good quartz-mines that is possessed by any other area of equal magnitude in the world.

Alluvial mining in Siberia gives little opportunity for scientific work. On most of the mines there is neither enough water nor enough grade to use hydraulic power, and even ordinary sluicing is only possible on a primitive scale. The gravel has more often than not to be carted to a washing-machine, which is of course an expensive method of handling.

On most of the mines that I saw, the gold-bearing gravel lay at a depth of from ten to thirty feet, and would average two feet in width. The proportion of overburden to gravel would average eight to one, and the cheapest method of removing overburden was the main problem the management had to face. The cardinal facts for the manager to arrive at when testing an alluvial area would therefore be (1) the width and value of the gold-bearing gravel, (2) the depth of overburden. If these be brought into relation by the known cost of removing a given quantity of overburden, the payability or otherwise of the area in question is arrived at.

In Central and Western Siberia, at the mines of the Lensky Company for example, the overburden is often so great that it

cannot be removed profitably, and here the gravel is mined by shafts and drifts. For this class of mining a great deal of timber must be used, and the proximity or otherwise of this requisite is a matter of importance.

As on the Klondyke field, the active period of alluvial mining in Siberia is limited to about five months in the year. There is some work done in winter, but the cost of removing densely frozen overburden runs up to at least three times the summer cost. In the Amur district, north of Manchuria, in mid-winter, I saw gangs of Chinese and Koreans working frozen ground on tribute. They commenced by going into the forest for a week and cutting wood. Then several days were spent in carting this on reindeer sledges to the mine. As the gravel to be worked was lying adjacent to a river at that time frozen over solid, their next task consisted of cutting away several feet of ice covering this area. Some days later a series of holes about 1 ft. deep and 5 ft. in diameter had been cut in the frozen ground. When these were ready, big piles of wood were laid above them and set fire to, and the ground was thawed sufficiently for the holes to be sunk another foot or so. This went on, with alternate fires and digging, until the gravel was reached, and the small quantity that was uncovered was taken out and carefully washed in hot water. From the small amount of gold recovered, the greater part was taken in royalty by the mine-owner, and what remained over was an insignificant return for the immensely hard work of mining it. There would be no profit on this work, but from their summer work these tributors would expect to make a fair wage.

The principal work done in winter is prospecting, and here the frozen ground is found to be a valuable ally. In the case of a gold-bearing gravel deposit lying fifteen or twenty feet below the surface in a mild climate, accurate testing by means of prospect shafts is hardly possible, as the ground is full of water, and would not stand. But when such a ground is frozen hard to this depth, holes may

be sunk down to the bed-rock and accurately measured sections of overburden and gravel taken out. On some of the mines I saw, this winter prospecting had been carried out on a systematic scale, and excellent plans, showing the widths of overburden and gravel in each hole and the value of the gravel, had been made. I have every reason to think that these plans, prepared in this systematic way from hundreds of prospect shafts, showed the approximate value of the areas in question.

The prospect shafts, from five to eight feet in diameter, are sunk by the help of wood fires, as described. When the gravel is reached, the material from each "tshetvert," or 7-inch section, is placed in a separate heap on the surface until the hole has got down to the bed-rock. Each heap is numbered relatively to the depth it came from, and a sample from it is washed separately, and entered up in a book. An average value is then struck for the total width of gold-bearing gravel in that particular hole, and that, together with the depth of gravel and depth of overburden, is entered up on the plan, as shown below :—

$$\frac{a-b}{c} \quad \bullet \frac{15-2}{1'40} \bullet \frac{18-3}{'91} \bullet \frac{13-3}{'24} \bullet \frac{9-4}{'80} \bullet \frac{13-2}{1'04}$$

a = depth of overburden in "tshetverts";
 b = depth of gravel in "tshetverts";
 c = "zolotniks" per 100 poods.

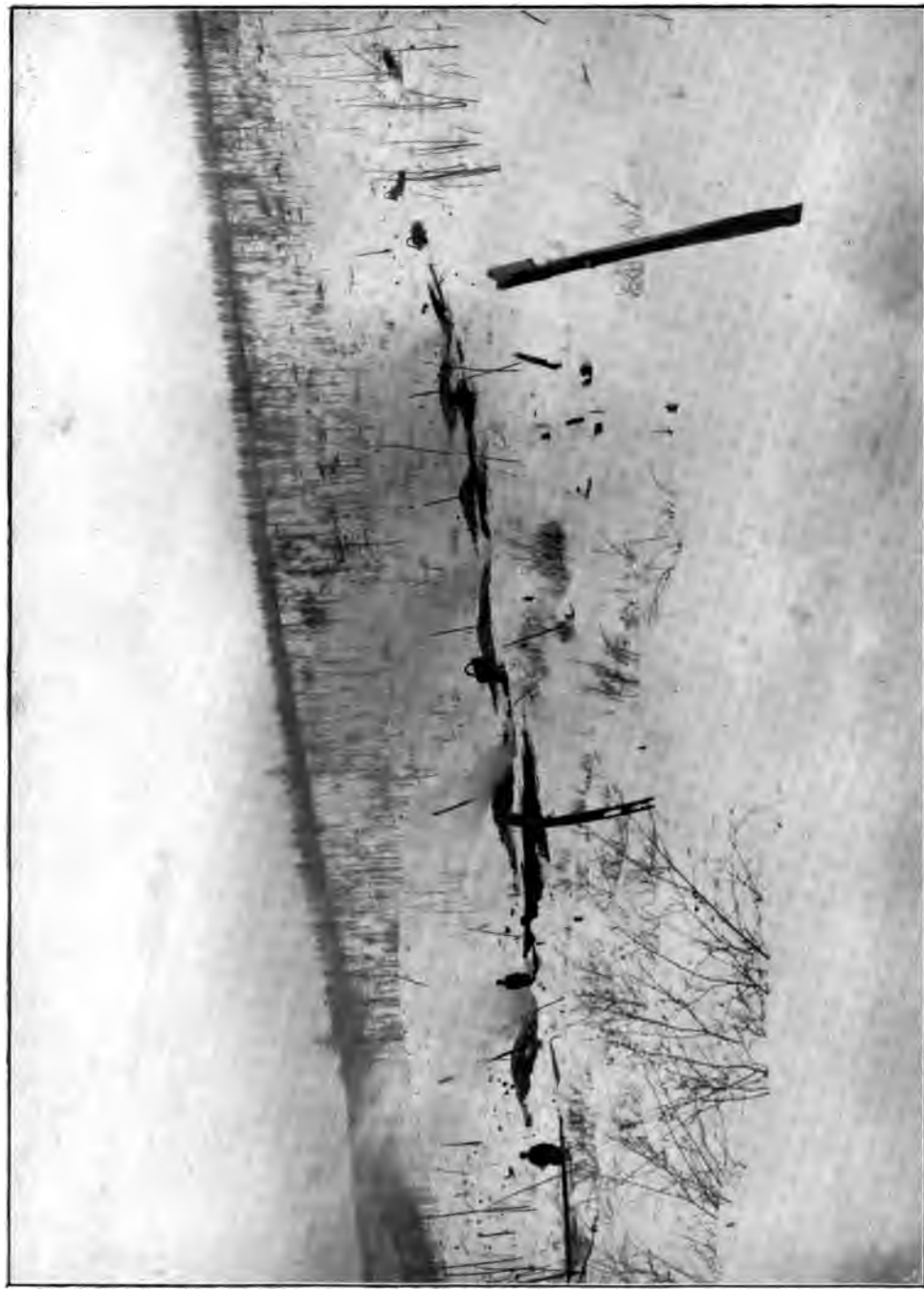
$$\bullet \frac{11-1}{'77} \bullet \frac{8-3}{1'06} \bullet \frac{13-3}{'64} \bullet \frac{12-2}{'64} \bullet \frac{9-4}{'38}$$

The values are arrived at by washing samples weighing about four poods, or say, 175 lb.; sampling is done under cover, on an inclined table, over which there is a regulated flow of water. The washing of the samples is not done so carefully as I think it ought to be; for alluvial, much of the gold I saw was exceedingly fine, and both in the sampling and in the actual treatment, there must be appreciable loss. Contrasting the alluvial deposits I saw in Siberia with those at Klondyke, it is to be noted that in the Klondyke gravels the gold is much coarser, and is concentrated in the lowest few inches of gravel and in the decomposed bed-rock; while in Siberia the gold is spread through the whole layer of gravel, and only a small proportion is found in the bed-rock,

On both fields all the bed-rocks I saw consisted of talcose schists, those at Klondyke being the more decomposed.

Washing the gravel begins in earnest in May, and continues for the short summer season of five months. It is then the out-of-date methods of the average Siberian mine-owner—his contempt for labour-saving appliances, his conservatism, and his crude system of accounts—show themselves. I cannot speak for the methods in use throughout Siberia, but will describe briefly those I saw on one of the three most important groups of mines in the country. On these alluvial areas all the overburden was removed and the gravel conveyed to the washing machines by means of carts and horses, over a hundred horses being used. The mines were located in a desolate region 500 hundred miles from a town, 1200 miles from a railway. The cost of conveying safely to this district these horses, which come from Tomsk, at the other end of Siberia, was very great, and the cost of feeding them, hay having to be brought hundreds of miles to the mines by sledge, at a freight of over 1d. a lb., was excessive. Altogether the horses and their drivers—what with food, wear and tear, and interest on capital were costing not far short of £10,000 a year. I pointed out to the mine-owner that the capital involved in the purchase of these horses would be sufficient to lay down on the mine enough rails and trucks to do all the work of removing overburden, etc.; that trucks, besides being more effective than carts and horses, did not require for each a driver nor stabling, nor did they consume hay to the extent of £4000 a year. I also pointed out that a labour-saving machine, such as a saw-mill, would pay for itself in a season. This man had asked me for advice, but I knew he was much too satisfied with his own methods to even give it serious consideration.

In analyzing the crude system of accounts kept on this property, together with the yields of gold from the various areas being worked, I was able to prove to my own satisfaction that some of these areas were being worked at a loss. But the management, which did not segregate its different mines' figures, or analyze its



THE AUTHOR PROSPECTING ALLUVIAL GROUND IN EASTERN SIBERIA



accounts, was in ignorance of this fact. This seemed a strange state of affairs for one of the biggest mines in Siberia, and it will one day land the proprietor in heavy loss ; but in the meantime he is making £50,000 a year, and cannot bring himself to take advice from a foreigner.

The conditions for gold-dredging in Siberia are in some ways favourable. Gold undoubtedly exists over many of the river-systems, and some of the areas that came under my notice as being possible for dredging, certainly carried quite a large amount. The fact that gold is spread through the gravel, and not contained largely in the bed-rock, is also favourable. But the serious factor against dredging in Siberia is the frozen ground. I am convinced that a great deal of the ground is frozen perennially, except just at the surface, and to erect a dredge on an area of this sort, however rich in gold, would mean certain failure. Other drawbacks, so far as dredging in Siberia is concerned, are : (1) The fineness of the gold. (2) The shortness of the season : work would last for only five months in the year, but the staff, among which would be several skilled English or American dredge mechanics, would have to be paid all the time. (3) The very large boulders and tree-trunks lying in the overburden : these boulders weigh up to a ton in gravels I inspected. With rich gravels to dredge, these minor troubles could be neutralized ; but the frozen ground is a thing that frightens me, and unless every area is thoroughly tested first in this respect, Siberia is going to add to the great number of gold-dredges which are lying rusting all over the world. In the Nerchinsk district I passed some dredging areas that were being prospected for the **Kara Company**, an English concern, and some of the machinery was already on the ground. I hope that those who are responsible for the management of this company will lay to heart my previous remarks.

The resources of the Russian Empire as regards reef-mining are almost unknown. The output from quartz-mines is less than

10 per cent of the total output, and this mostly comes from the Urals. There is a hazy notion among mine-owners and engineers that the reefs ought to be exploited, but from what I saw of these people they will furnish neither the initiative nor the knowledge, for a long time to come, for placing this branch of mining in the position it ought to be.

On one alluvial mine I inspected, a perfectly defined quartz-reef 40 ins. wide had been exposed in two trenches, 60 ft. apart. The ore showed a value of about £6 a ton in gold, and was as hopeful a prospect as I had ever seen. And yet the owner of the mine, who was a very rich man, and was spending large sums in prospecting unpayable alluvial areas, was doing no work on this reef, and seemed to regard it as a curiosity, rather than as a prospective asset of value. This same man, funnily enough, was actually opening up a reef on another property, and only stopped work on it when I told him the reef had no gold in it. This man is one of the shrewdest alluvial mine-owners in Siberia, but he knows less than nothing about quartz-mines, and is an example of the rest.

The **Nerchinsk** is the only English company I know of which owns quartz-reefs in Siberia. In discussing the chances of this mine with its manager, I came to the conclusion that as a mine it has fair prospects; but I believe that its cash resources are out of all proportion to the heavy initial expenditure that must be expected. If the Imperial Cabinet—the ground landlord, so to speak, of the Nerchinsk Concession—wishes to attract foreign capital to Siberia, it seems to me that it might assist in the financing of this venture.

The Russian Government professes to be anxious that foreign capital should participate in the development of Siberian mines, and, presumably, that the most up-to-date methods of working should be introduced. So far there has been almost no English capital there, and the several French and Belgian companies, formed on unsound lines, have been failures. In the last year or two the Americans have shown some interest in Siberian mines; and if the mines

offered them, and the conditions existing, appear to them satisfactory, I imagine they will secure the best things before any one else comes into the field. Personally, I hold the opinion that English capital should as yet only be placed in Russian or Siberian gold-mines by professional mining people. There is plenty of alluvial gold still in Siberia, and there must be many potential quartz-mines in both Siberia and Russia. My reasons are not based on any probable lack of gold; they are based, rather, on the general conditions which there govern mining, and which may be referred to under the head of racial, political, and economic.

The racial conditions raise the question of the Russian language and the Russian temperament. These two phases are of quite first-rate importance in a study of the subject. Supposing an English company were to buy a valuable newly discovered quartz-mine in Siberia. Its first duty would be to secure a manager of high standing. There are no Russian engineers of standing who know anything about up-to-date quartz-mining, and a foreigner, either English or American, would have to be selected. But there is no English-speaking engineer I know of who has even a second-rate knowledge of Russian. Such a manager would have to employ an interpreter; but to do his work through an interpreter, especially a man lacking in technical knowledge, who could not convey his exact meaning to the subordinates, would ruin the manager's nervous system in six months. The manager would also require English-speaking assistants, for the Russians, either in its technical or commercial side, are not trained to quartz-mining; and the idea of mine-captains, surveyors, assayers, mill-hands, and accountants, proceeding to their work each accompanied by an interpreter, and that man in secret sympathy with the native workers on the mine, would be too appalling to contemplate.

And then, the Russian temperament is as hard a thing for us to understand as the Russian language. The English- or American-born mine-manager would want to have things done his own way;

but he would find that the Russian foreman and the men under him had their way of doing things, handed down through generations of miners, and to insist on his own methods would make secret enemies of all his employees. If he dismissed them, their places would be taken by others holding the same ignorant views, and prepared to act in the same way. Then, if the manager were a man of energy, and wanted to run his mine at express speed in the summer months, to make up for the time lost during the long winter, he would also find this course impossible. The Russian workman on the mines is not accustomed to consider time as a factor. One day a week—at least, it seemed to me so—is a Saint's day, and he takes a holiday. Another day he stays at home to get intoxicated. It is his temperament to take life slowly, and a matter of indifference to him whether the mine works at a profit or not. The manager may grow grey in his efforts to earn dividends, but he will fail to alter the Russian way of doing things.

Then there are the political conditions. It is to be noted that a foreigner may own mining leases in Russia or Siberia, except in the Trans-Baikal territories, where the title can only be held by a Russian, or Russian company. These territories probably contain the richest alluvial mines yet to be worked, and if an English company wished to buy one of these mines it could only do so by registering a separate company in St. Petersburg, and transferring to itself all the shares of that company. This means the cost of an extra office, and extra set of directors, who would have to be Russians. It is not a method of administration that commends itself to me. It is essential, I believe, that any foreign mining company, operating in Russia, must have an influential agent in St. Petersburg, whose duties are of a semi-political nature. This personage, by his influence, would smooth the path of foreigners unacquainted with the administrative routine of the country; his fee would have to be added to the cost of the St. Petersburg office.

The Russian mining laws are liberally conceived. The payment to Government for alluvial areas, and for timber and fuel, and hay-



A GRAVEL MINE IN EASTERN SIBERIA



cutting rights are small ; as against this the tax on profits, especially if these amount to over 10 per cent on the capital, is heavy. There are, however, altogether too many official restrictions, framed in ignorance of up-to-date quartz-mining ; some of these are sufficient to kill such an industry in its birth. The English-speaking engineer, for instance, who wished to order a consignment of dynamite, would probably be so disgusted at the regulations to be observed to secure a permit, and at the further delay before the dynamite arrived, that he would resign and leave the country.

The economic conditions are prejudiced by a climate which stops, or seriously restricts, mining for seven months in the year. Quartz-mining in a climate such as Siberia in winter, presents novel features, and numerous problems which can only be solved by experience. Such factors, for instance, as the heating of the whole plant, and the collecting of sand, slimes, battery water, and cyanide solutions, under the same roof, mean high working costs, and would seriously reduce the usual margin of profit on low-grade ores.

Distance is another economic factor to be reckoned with. Some mines in Siberia are near the railway, but most are not. One that I visited was 1200 miles from the railway. There are no roads, and these immense distances must be covered on the rivers—in summer by water, in winter on the ice. For three months in the year, when the ice is forming and when it is thawing, the mines are cut off from the world, while, at the best, communication is uncertain and transport costly. As a rule, mines are not economic successes when so far removed from their supplies.

In conclusion, none of the drawbacks to mining in Siberia which I have enumerated are insuperable, but they one and all mean higher working costs. It must, I think, be definitely laid down, that a low-grade mine in Siberia, under these conditions, will for a long time to come be of doubtful value to foreigners ; although in other parts of the world, where conditions are favourable, low-grade mines turn out to be the most valuable in the end. There are still good alluvial mines there ; but the value of these is too well known by

the Russians, and we could only get them by paying more than they are worth.

On the whole, unless something exceptional in the shape of a really sound quartz-mine where facilities are unusually good, is put in our way, I think the British should not for the present venture their capital in the gold-mines of the Russian Empire.

Some day Siberia may become a great quartz-mining field, but I do not see my way to indicate that such eventuality is yet at hand.

CHAPTER XIII

THE GOLD-MINES OF THE UNITED STATES AND ALASKA.

THE States and Alaska continue to record a gold output of over \$80,000,000 a year. For 1904 the estimated figure was \$84,500,000. The principal producing States were :—

			\$
Colorado	.	.	24,200,000
California	.	.	18,500,000
Alaska	.	.	9,000,000
S. Dakota	.	.	7,200,000
Nevada	.	.	5,000,000
Montana	.	.	4,900,000
Utah	.	.	4,600,000
Arizona	.	.	4,100,000

An increasing proportion of the output each year is furnished, in the shape of a minor product, from copper and silver ores. There is also an appreciable increase from dredging ; this applies mainly to California, but is not confined to that state.

Among quartz-mines, a falling-off in the yield from Cripple Creek is likely to be balanced to a certain extent by the new discoveries in Nevada ; but so far as can now be estimated there does not seem much prospect of an increased yield from quartz-ores.

The gold-mining industry is mainly controlled and owned by American capital. Many of the good mines are owned privately. The American mine-owner understands his business, and often makes a fortune out of working a mine. The Britisher, on the contrary, turns his mine over to a company, and relies on making

his fortune on share transactions. If the American can dispose of his mine for more than it is worth, he sells it to Britain. At least, he used to. But we have begun to understand the rudiments of mine-valuation, and do not buy worked-out mines at inflated prices so frequently as before. We are still prepared to buy mines from America—as many as are offered—but on a basis of ore-reserves rather than of sentiment. We should like to see two-thirds, at least, of the purchase-price in sight, as net profit, with the mine looking well in depth. It is not an unreasonable request after all.

The sale of the Camp Bird mine, to British holders, was made on, roughly, just such terms. It has turned out a successful purchase. The terms of sale included a royalty, or deferred payment, to the then owner, contingent upon profits from unexposed ore. This, too, is a reasonable stipulation. We don't object to agree to a deferred payment for unexposed ore ; but to pay cash down, on the chance of finding unexposed ore, is a procedure which has begun to make us tired.

Colorado is the most important gold-producer of the States. This state yields—in addition to gold—silver, lead, copper, coal, and iron.

The metal-mines are found high in the mountains, either on spurs, or along the main range of the Rockies. From north to south, along the range, the chief gold-mining camps are Boulder, Gilpin, Cripple Creek, and the San Juan.

The first discovery of gold in Colorado was in 1859. This was in the locality now known as Gilpin country, in a district which, although only four miles by three, has since produced over \$100,000,000, mostly in gold. The lodes have been worked continuously for forty-five years. Owing to the great number of lodes traversing the belt in all directions, local mining companies have preferred to work all the reefs down to a comparatively shallow depth rather than a smaller number to the extremity of their pay-chutes. At the time of my visit there was only one shaft below 2000 ft. ; most of the others ranging between 700 ft. and 1200 ft. This compares poorly with the record of another old



A SECTION OF CRIPPLE CREEK GOLDFIELD

mining field—Bendigo—where there are dozens of shafts below 2000 ft., and at least ten below 3000 ft.

This shallow mining at Gilpin is only explained by the supposition that the ore becomes poor in depth. But the reefs certainly continue of undiminished size, and so far as I could see there was no appreciable falling-off in value. In the **California** mine, then 2200 ft. deep, there was payable ore in the bottom; and in the **Cook** mine, at 800 ft., I saw a highly mineralized reef. That was some years ago.

Gilpin Country mines require, and I think deserve, more working capital. This should be sunk in development. In the past, everything has been done from hand to mouth, and no ore-reserves have been built up.

With Gilpin may be coupled the adjoining Boulder and Clear Creek districts; but in these latter the lodes show a more marked impoverishment as they get deeper. To cut some of these in depth—at many hundreds of feet below their then lowest workings—the Newhouse tunnel was put in by the **Argo Mining and Tunnel Company**. This, at the time of my visit, was two-and-a-half miles long, and was 12 ft. by 10 ft. in size. The lodes were cut one after another, well defined, and with heavy seams of mineral, but have turned out low-grade; once more establishing the almost invariable phenomenon of impoverishment with depth.

The mines at Cripple Creek extend over a length of five miles, and a width of perhaps three miles, and lie on the sides of mountains, at an elevation of nearly 10,000 ft.

The formation is volcanic. In the heart of the gold-belt is the vent of a crater, or of several, but the exact locality of these, so far as I know, has not yet been determined. The volcanic rocks are, in turn, underlaid by granite. In the centre of the area, granite has not yet been reached, but where met with towards the sides it has proved, as a rule, adverse to the continuance of rich ore.

The **Stratton's Independence** is a case in point. Highly productive to a certain depth, the lodes eventually entered the underlying

granite, and the values gradually faded away. The lower part of the mine has now been abandoned, and the pumps drawn. The upper workings, a very network of small, rich veins, have continued to produce good values for two years longer than they were estimated to do, but it seems unlikely that the end of 1905 will see much good ore remaining. The company will then have a fair reserve of cash, and may be able to acquire interests elsewhere.

This has been a most valuable mine, and has more than justified the report on which it was floated. That investors were carried away by the large profits, and forgot to set the bulk of these aside for redemption of their capital, was unfortunate; but it seems to me that this provision for redemption will be systematically ignored in the case of every mine, by the majority. The other English-owned Cripple Creek mines are either in liquidation or shut down.

Of locally owned properties a number still pay well, but not so well as in the past. The **Portland** is the biggest producer on the field, and the **El Paso** is the mine which has improved most in the last year or two.

The yield from this field in 1904 was probably \$16,000,000 and the monthly treatment of ore 55,000 to 60,000 tons.

There is no doubt that much of the richest ore of the Cripple Creek field is exhausted, and that a steady falling-off in depth, both in bulk and value, is taking place. It is too soon to say that this, the most important gold-field in America, is worked out—for it is not worked out; but, like Kalgoorlie, it has passed its zenith, and is likely to show a falling output of gold.

In the south-west of Colorado lies the important San Juan mining district. The gold-mines there are situated on the spurs of the Rocky Mountains at between 10,000 ft. and 12,000 ft. Railways tap the valleys, and from the termini supplies are packed to the mines by mule trains. In winter this is done over deep snow. Aerial trams usually carry the ore from the mines to reduction plants lying farther down the mountain sides, where the winter flow

of water is greater, and where there is less danger of snow-slides than on the steeper brows.

All the mines are worked by adits. The geologic formation of this section of the great mountain range is unusual. Up to about 9000 ft. the rock is sedimentary, consisting of wide layers of red sandstone and conglomerate, dipping at an angle of fifteen degrees to the north. Lying directly on the top of this is a layer of andesitic breccia about 2000 ft. thick; and above this again, stretching up to the top of the highest peaks, is a rock which geologists describe as almost a lava. The slopes of many of the mountains are covered with debris worn away from this highest stratum of rock.

Fissure lodes can be traced for miles running through the mountains, and the quartzose filling of these, especially when they pass through the breccia, often yields chutes of valuable ore. Curiously enough, these quartz-filled fissures carry all sorts of metals within a small area. Some reefs are free-milling gold-ore. More are of gold, with silver in addition. Most of all there are reefs of silver. Copper occurs in small quantities, and in some of the reefs there is a good deal of zinc. I saw in the Menona mine a vein of nearly solid mineral, carrying gold, silver, lead, zinc, and other metals. A quarter of a mile away the Argentine reef of the Tomboy mine carries a free gold quartz. Still nearer is the Japan mine, of silver and lead ore; and a mile farther on is the Smuggler-Union vein, carrying nearly equal proportions of gold and silver. Over the mountain is the Camp Bird, another free gold-ore—and so on. The fissures extend down into the sedimentary rocks, 1000 ft. below the deepest of these mines. It is, however, unlikely that the mines now working profitably high up in the breccia, will extend down to this horizon. The reefs certainly go down; but they will, I think, have lost their payable contents before reaching that depth.

About eight miles from the mining town of Ouray, and at an altitude of over 11,000 ft., is the **Camp Bird** mine. At the time of

its purchase, some three years ago, the net profit exposed in the ore-reserves was equal to about two-thirds of the purchase price; in addition, the mine looked exceedingly well at the points of development. A fine equipment and a sixty-stamp mill were also included in the price. With regard to the unexposed ore, it was stipulated by the then owner that the company should be liable to pay him one-quarter of the profits from this source until such time as he had received an additional \$2,000,000, after which time his interest in the mine ceased. These were fair terms. Development work rapidly exposed more ore. After three years' working, the mine has a bigger profit in sight than at the rate of purchase; while the late owner is already drawing his royalty on the then unexposed, but now profitably worked, ore.

It must not be inferred that the prospects of the mine are to-day better in all respects than at the time of purchase. The ore-reserves are larger, and there is a substantial cash fund built up. On the other hand, some parts of the mine have not been proved to carry so much ore as was expected, while in the lowest level of all the results, at the time of writing this, are somewhat uncertain. The mine has, no doubt, a number of years of profitable work ahead; but the shareholders must remember that the best mine in the world—and the Camp Bird has certainly proved one of the best—must end some time, and that it is incumbent on him to redeem his capital.

Looked at in this light, the over-capitalized mine quickly loses its glamour. This, as mines go, is not much over-valued, but in view of the poorer results in the lowest level, the profit in sight should more nearly correspond to the market valuation than it does. As the profit in sight cannot be expanded artificially, the market value of the mine should contract to meet it; which means that the shares, for security's sake, should stand lower than they do. At a later stage, should the ore again improve in depth, there would be room for expansion in the price.

The profit in sight at present, with the shares at £1 14s., is about 65 per cent of the market valuation.



TOMBOY MINE, COLORADO—12,000 FEET ABOVE SEA-LEVEL

Over the mountain range from Camp Bird, though not more than a mile or two in a direct line, is the **Tomboy** mine, whose lode outcrops at over 12,000 ft. above sea-level. The old Tomboy reef, worked at a profit for some years, got poor in depth. Below about 800 ft. there was no payable ore at all, so the company sensibly acquired the neighbouring Argentine reef. This at first yielded some rich ore, but as development progressed the average fell lower and lower. To-day the recovery value is a bare \$8 a ton—a payable, but low-grade figure. In one respect the Tomboy mine of to-day is well off—in the quantity of the ore. Although of low average value, the reef is persistent over a great length, and as it is usually not less than 6 ft. wide, the tonnage works out substantially. At the last report there were 430,000 tons exposed on the new Argentine reef; but taking ore in sight and ore indicated, I would place the figure a good deal higher than this.

There is good equipment, and a sixty-stamp mill. This is not large enough for a mine of such capacity, and a mill of at least a hundred stamps is called for. A scarcity of water, in the winter, has tied the hand of the management in this respect, but should the difficulty be overcome, and a further water supply assured, there seems every reason to increase the mill to a hundred stamps.

The development of the mine, and the profit-earning stage, have been retarded by a strike, lasting for nearly a year and disorganizing the local labour supply. Working costs, owing to this strike, and to the inferior class of labour that was installed during its progress, rose decidedly, and have not yet fallen back to the old figure of about \$5.5 a ton.

On the present basis of costs the ore-reserves show a profit in sight of \$650,000, equal to 44 per cent of market valuation; but I am inclined to expect that expenses will again fall, and that more than this will be earned. There is also the expectation of a hundred stamps one day being at work, thus bringing about a further reduction; while the life of the mine promises to be long.

Farther down this same mountain is the **Smuggler-Union**. This was for many years a notable mine. At first it was worked as a rich silver-mine; but in depth the ore became low-grade, and now carries more gold than silver. Some of the stopes in this mine were a mile long, and the vertical depth, from the highest part of the outcrop to the lowest point worked, is 2500 ft. The average width is 4 ft.

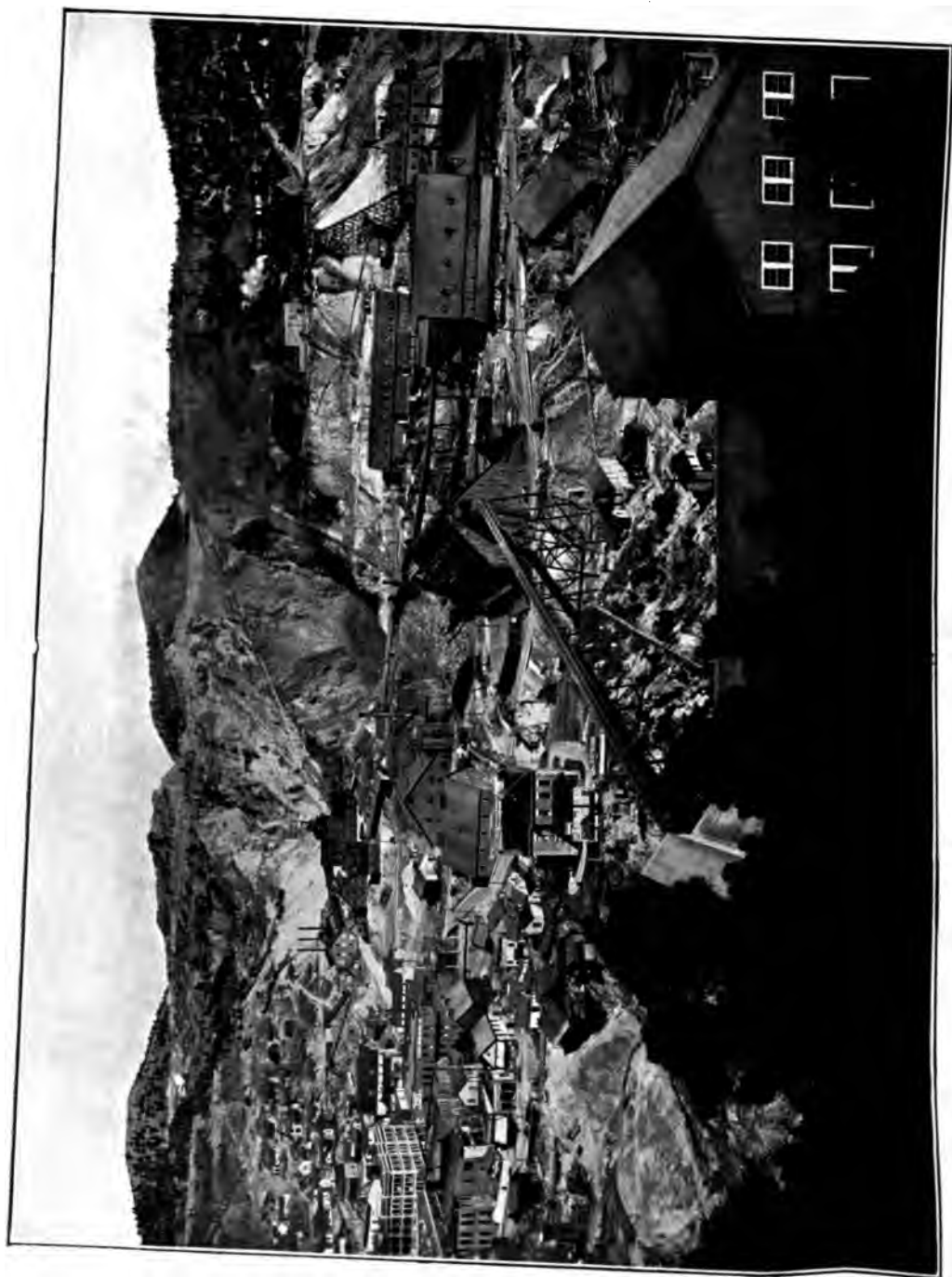
At the time of my inspection, when 16,000 tons a month were being mined, the recovery value of the ore had fallen to about \$6. Since then, despite immense ore-reserves and fine equipment, the value has further fallen, and the mine has been shut down.

The **Menona** and **Liberty Bell** mines in this neighbourhood are now closed.

In South Dakota, gold-mining is confined to the Black Hills district, which was first opened in 1876. The mining centre is Deadwood. Three miles distant is Lead City, which has grown up round the Homestake mine.

It is sometimes assumed that the Homestake is the only payable mine in the Black Hills. This is a mistake. There are several other payable mines in the district, and to my mind there are the makings of a good many more. These are all low-grade deposits, but of great size. A great deal of capital must be laid out on such mines—which perhaps frightens people from handling them seriously—but my belief is that as time goes on their potential value will become apparent. I do not suppose these deposits will yield \$4 a ton; the Homestake itself does not yield that now, but at the figure to which local working costs have been reduced a lower yield would show a profit.

There is perhaps one drawback—the scarcity of water. The big mine has secured all there is for miles round, and spent \$1,000,000 on bringing in a further supply from a distance. If other mines start to work on a large scale, they will not have enough water to crush their ore on the spot, and will have to send it by rail to suitable mill-sites nearer the plains. Two railways run branches into



THE HOMESTAKE MINE, SOUTH DAKOTA

the Black Hills, so that this question of transporting the ore to water can be overcome.

The **Homestake** is the biggest gold-mine in the world, both as to the bulk of its ore-deposit and the magnitude of its plant. There are now 1000 stamps at work, crushing a matter of 1,450,000 tons a year. Compared with this, the Alaska Treadwell follows with 540 stamps, crushing 750,000 tons a year. The Simmer & Jack is to have 360 stamps. The Waihi has 330. The present Homestake Company is an amalgamation of half a dozen mines working along the line of the giant ore-deposit. Each of these smaller mines originally worked the lode by an open quarry, and a series of these quarries now exist for a distance of two miles along the surface of the property. These workings still furnish some ore, but the bulk is now taken from the deeper underground workings, which are reached by shafts.

The ore may be described as a quartzified schist, bedded in the formation, and varying from 50 to 400 feet wide. It has been proved to continue as far as the shafts have yet penetrated—to 1200 feet. It is said that the ore exposed and indicated is already enough to last for from fifteen to twenty years more; but on the part of the management there is absolute reticence on this point. The pitch of the deposit is to the south, and at a certain depth it may pass out of the Homestake ground. Long before that depth is reached, no doubt, all possible extensions of the ore will have been secured, and provided only that the value carries in depth, the mine may go on to an indefinite time.

As regards the value of the ore, this has fallen something like 50 cents a ton in the last year or two, but on treatment of a greater quantity. The recovery per ton used to be just under \$4, and is now under \$3.5. Even on this low figure the total yield of the mine in 1904 was over £1,000,000 sterling.

Working costs are round about \$2.50 a ton, of which underground filling and timbering is the heaviest item. It seems unlikely that

this figure can be improved on. The 1000 stamps are in six batteries, placed at different points along the line of lode. Each stamp weighs 900 lb., and crushes about four tons a day. I learned from the manager that in winter, when the temperature of the mill water falls to a low point, the plate recovery shows a distinct improvement. The whole equipment of the mine is of the best. At the company's foundry, castings are made of all that is required on the mine, including its special type of mortar-box. The cyanide plant is, naturally, the largest there is. The tailings are concentrated down to one-half, having a value of about \$1.50 a ton. These clean sands are treated in 600-ton vats for seven days. The extraction, at the time of my inspection of the plant, was about 70 per cent, or, say, \$1 a ton, and the costs were less than 50 cents. It was expected they would be got down to 35 cents, while a project for treating the slimes, worth about \$1.25 a ton, was also under discussion.

It is probable that Homestake shares are now a safe investment, as in the last year or two they have dropped considerably in price. But those who control the mine do not furnish details of the ore-reserves, which can only be guessed at.

Near the Homestake lode, and parallel with it, is a series of other immense lodes, similar in formation. I assume that most of these are too low-grade to work.

Three miles distant is the **Golden Reward**, a mine owned in New York, which is also a large producer. The reef being worked at the time I was there was a flat contact vein, lying between quartzite and phonolite. This was of high value, was four feet wide, and existed over a large area. But more interesting than this was the overlying phonolite. This had been cross-cut into and opened up at several points. It was hundreds of feet thick, of great area, and was definitely stated to average over large patches \$5 a ton. It was a free-milling rock, amenable to cyanide, and I formed the idea that this mine had the makings of a Homestake. The ore would have to be carried by rail to a mill site where there is water, but

beyond that, expenses should be usual. The quantity in sight figured out at many million tons.

Another valuable mine is the **Horseshoe**, which in 1904 produced \$412,000. There are a dozen small producers of not much present value. Some of these have, however, big potentialities in the shape of large ore-deposits peculiarly amenable to cyanide, and, in my opinion, only require the spending of money to turn them into valuable properties.

In **Nevada**, in the last year or two, several rich gold-fields have been discovered. The first of these was Tonopah, found in May, 1900. The mineral zone here is several miles in extent, and the ore occurs in volcanic rocks. The values are unusually high, and consist of gold and silver fairly evenly divided. The ore is a smelting ore, and is carried by rail to San Francisco. The principal mine of the fields—the **Tonopah** Mining Company—is valued at present at \$11,000,000.

About twenty-seven miles distant is the Goldfield district, discovered in 1903. Here the ores are also found in volcanic rocks, but are free-milling so far. Several mines have already yielded large amounts from patches of exceptionally rich gold-ore. Values have been found over an area several miles in extent. The sulphide zone has already been reached by several shafts, but it is reported that the values show no falling-off at that depth. It seems not unlikely that this district will become an important field.

Eight miles south the Bull Frog district was discovered, in 1904. The prospects here are also said to be favourable.

Taking note of this series of important finds, the prospects of Nevada as an increasing producer of gold are assured. As yet British capital has not taken any share in these new fields.

California, among the States, is now second, as a gold-producer, to Colorado; but since the first discoveries in 1849 it has yielded

more gold than any country in the world. The total is over £290,000,000. Next to this comes Victoria, with over £270,000,000. All other countries are far behind these figures.

There are no big mines in California at the present time. Probably no individual mine yields as much as \$60,000 a month, but there are some yielding as much as \$40,000.

There is gold-mining, of a sort, nearly all over the state, but outside of one or two main districts it does not count for much. Here and there an outside mine is doing well; but the value of such mines, and their signs of permanence, are much exaggerated locally.

The "Mother Lode" is the real backbone of the California gold-mining industry—just as much so to-day as it was thirty or forty years ago. This is an immense fissuring of the country, running continuously for a great distance, and carrying within its zone an almost incalculable quantity of quartz. The length of this belt is over a hundred miles. It commences, in the south, in Mariposa, and can easily be traced continuously through Tuolumne, Calaveras, Amador, and El Dorado counties. It then dies out again.

In places this belt is as much as twenty miles wide. Other parallel lines of quartz are found across this area, but these do not run continuously. The main fissure—the "Mother Lode" proper—runs through the belt, and seems to have a width of several hundred feet. This formation is composed of tilted schists and shales, with an occasional band of igneous rock, and everywhere big veins of white quartz. These white quartz outcrops can be traced along the belt from end to end. The general dip of this formation is from seventy to eighty degrees. Some of the quartz bands appear to conform to the dip, others again look to be dipping at a flatter angle. The Mother Lode has been worked for over fifty years. One mine I visited, the **Keystone**, has been worked for that time without a break. Many others now at work were started as long ago as this, but have not been worked continuously. The deepest shaft—that of the **Kennedy** mine—

was, when I was there, about 2500 ft. This does not compare at all with Bendigo, another old field, where there are many shafts below 3000 ft. ; but the mining conditions of the two fields are not alike. In the earlier days a number of the Mother Lode mines were extraordinarily profitable. Probably twenty-five or thirty of them yielded gold worth from \$1,000,000 to \$13,000,000, and a profit varying from several hundred thousand dollars up to five or six millions.

The amount of quartz in the Mother Lode, as has already been said, is too great to be estimated. The bulk of it carries no gold, or only a fractional quantity. There are many millions of tons that carry from \$1 to \$3, and a great deal that will average from \$3 to \$5. Ore worth \$5 on the Mother Lode to-day is high-grade. But in the old days many patches were found—such as have long been exhausted now—of really rich ore. It was from these patches that the big profits were made. Needless to say, this rich ore was generally near the surface, and it got poorer as it was worked deeper. I believe that all the best ore came to an end long before 1000 ft. was reached.

Californians may deny this. They will point out that a mine here and there got a lot of good ore below 1000 ft. ; that rich pockets are always being found, even now ; and that not long ago in the Kennedy, at 2300 ft., the deepest stope on the lode, such a pocket was discovered.

I can only reply that I inspected fifteen mines on the lode, and came away with the impression that they were mostly working from hand to mouth. The ore now worked—after all these earlier years when the best ore was taken out—is excessively low-grade, and I should say that, on the whole, the Mother Lode is being worked to-day—if taken from end to end—at no profit.

The ore-bodies in this great fissure are not continuous. I believe them to be lenses. Such a chute of ore may be 200, 500, or 1000 ft. long. This will then die out, to be replaced farther on by another ore-body. In depth these lenses seem to be more persistent. For example, a lens 200 ft. long might last down for

1000 ft., or one 500 ft. long might go down for 1800 ft. These would then give out in depth, but sufficient exploration might then discover another ore-body which had not existed near the surface. It seems quite safe to assume that the ore goes down to greater depths than any shaft will be able to follow it. In the Kennedy mine, at 2300 ft., I saw a quartz-reef 75 ft. wide. This is the deepest level that has ever been opened on the Mother Lode.

But as to their gold contents, there is no such certainty. As I have said, nearly all the mines are now reduced to working such a low grade of ore that they make hardly any profit. Most of the ore treated on the Mother Lode to-day yields less than \$3 a ton.

I will assume that the ore in the bottom of all the mines is *not* getting poorer than the present average, and that there are many millions of tons in sight that will yield, say, from \$2 to \$3.50; but is this going to be worked at a real profit? The big stope in the bottom of the Kennedy mine, for example, showed hundreds of thousands of tons of ore, but if this were milled in bulk, in the present forty-stamp mill, it would only yield a little over \$2 a ton—and at a loss.

It may be accepted as a correct estimate that the average return from Mother Lode ore now being mined is barely \$3 a ton.

Here is a big group of mines working at considerable depths, handling a soft formation which requires heavy timbering, hauling the ore to the surface, milling it, concentrating it, and treating the concentrates by chlorination, keeping their plants in repair, and sinking deeper every year—and the average yield of the ore they mill is only \$3—say 12s. 6d. a ton.

No wonder there is no profit on the ore. The only surprise is that there is not a heavy loss. But it is because of the rare mining facilities of this belt that the thing is possible.

The mining advantages of the Mother Lode are these:—

Big ore-bodies, which rarely give out in depth.

A free-milling ore, which, after milling, can be readily concentrated.

The best mining machinery, manufactured locally, and sufficient capital to have this erected from the start.

Direct water power, or electric power generated from water power; this can also be supplemented by oil fuel.

Local timber, which will furnish the immense props required to hold the soft ground.

An accessible district, where living and supplies are cheap.

A good class of labour, as yet untainted with unionism and strikes.

Two local mining universities which supply highly-trained officials to all the mines.

The drawbacks are :—

A very low-grade ore.

A soft formation, which requires expensive timbering.

The ore-bodies are rarely as small as 3 ft.; oftener they run from 8 ft. or 10 ft., to 20 ft. or 30 ft.; sometimes they will open out to 100 ft. Much of this ore is worth less than \$2, in which case it is left behind. In most of the mines all ore over \$2 is taken out, as, including the richer patches, the average would be brought up to a recovery of about \$3. The stopes are always carefully sampled and assayed from day to day.

The ore is crushed by stamps of a usual weight of about 1000 lb. Amalgamating in the mortar-boxes is rare; instead, a copper plate of extra length is used.

The tailings are concentrated on frue vanners, or tables of a similar make. Two tables to five stamps is about the usual proportion; but where three are used, there is a better extraction. The tailings probably average 40 cents a ton after passing the tables.

The concentrates run about 5 per cent; their value when clean averages over \$50 per ton. Their treatment is by chlorination. Some of the mines have their own plants, where the cost of treating a ton of concentrates is about \$8. When they are sent by rail to a public works the cost is nearly double this.

The machinery used on all the mines is good, and well adapted to the work. As regards machinery equipment, and shaft-sinking and development, the mines are well financed and well handled.

They often are failures—but it is because the ore is poor, not because they are badly managed.

The Mother Lode runs through the foothills of the Sierras. On the higher slopes, water is abundant. Power is generated up here by a number of electric companies, and these supply the mines at prices varying from \$5 to \$6.50 per h.p. per month. The same companies own ditches many miles in length, which bring water in for the batteries, etc.

Most of the mines do all their work with electricity—milling, hoisting, pumping, sawing, but in cases the hoisting is done with steam. For this oil is used as fuel; it is California oil, and compares favourably with electricity at, say \$6.50 per h.p.

The **Utica** mine has its own water supply, and uses water power direct for everything. Its hoisting engine, on the Stickle shaft, is one of the finest I have seen. In this shaft a skip is used for baling water, which holds 1500 gallons.

The forests of California, which lie not far from the Mother Lode, supply most of the mine timber used; but some, also, comes from Oregon. In the square sets used for propping the stopes, it is quite usual to put in 16-inch timber. This is an unusual size, but the ground is generally so soft that there is no alternative. Even then the stope has to be at once filled with waste, which is got by putting cross-cuts into the walls.

After stoping has gone on for some time in a mine here, the whole formation gradually begins to settle. Not only are the timbers in the stopes crushed and twisted, but those in the drives are equally affected. I saw in drives in the **Oneida** mine 16-inch props—only put in a fortnight—cracked in two and worthless; the timber-men were at work putting in others alongside of them.

This item of timbering, and of repairing ground already timbered, is the heaviest in the cost sheet of Mother Lode mines. Were it not for this drawback of soft and treacherous ground, the mining condi-

tions would be nearly perfect. I suppose that on a total cost of, say, \$2.50 a ton the purchase, haulage, cutting, framing, and renewing of timber, runs away with 75 cents—nearly a third. If it were not that this immense timber grows close at hand—if, for example, the mines were where Broken Hill is, or the Rand—it would not be possible to work the Mother Lode ore without a big loss.

The climate is good. The district is served by railways, which, however, do not come right into the mining belt, and supplies are moderately cheap. Labour is of a high standard, and the unions have not a strong enough grip to make their disturbing influence felt.

Finally, there is to be had in San Francisco about the best scientific and practical mining education in the world. The men who are being turned out from here usually begin their careers on the Mother Lode mines. With this groundwork, and with the practical knowledge they then gain of such special branches of mining, as the use of big timbers, close concentration, electric and water powers—and, more than all, the treatment of low-grade ore, where economy is essential—it is not to be wondered at that these men soon become absolutely proficient.

And so we find the young Californian engineer, or mine-manager, going to-day to take up well-paid mining positions in Australia and South Africa, and the young Englishman, who has as high a character, and as good brains—but a bad training—wonders why he is being passed over.

British-owned mines on the Mother Lode are not at present doing well. The most interesting of these is the **Royal Consolidated**, which has an immense reserve of ore reported as being worth on an average \$2.50 to \$3. There is a big debt, which must be got rid of before the mine can do much good; but in any case the margin of profit will be a small one. There are 160 stamps.

The **Jumper** mine, a Glasgow company, some years ago was working the best ore on the Mother Lode. This is now exhausted,

and the present ore is poor. Other Glasgow-owned mines are the **Crystalline** and **Nonpareil**. Both are of low grade.

Interesting as this field is, I can only conclude that it is now being worked at no real profit. Most of the mines are shut down. If these should be restarted they will admittedly have to work ore that will not yield on an average over \$3 a ton. At the best this can mean but a few cents a ton net profit.

Such mines as the **Utica**, **Keystone**, and **Oneida** can work on this basis, because they have large and fitting equipments, paid for out of earlier profits; but if they had to-day to face the problem of a total new equipment, I doubt whether their owners would face the risk involved.

There are numerous other quartz-mining fields in California, but my personal knowledge of these is limited. Most of the mines are small and owned locally. Probably the **North Star** mine, in Grass Valley, now worked to nearly 3000 ft. deep, is the best of these.

The Hydraulic industry in California, which up to fifteen years ago added a lot of gold to the output, is almost at a standstill. It was found that the debris washed down by the nozzles and run through the sluices, was blocking up the rivers lower down, and overflowing rich agricultural land many miles away from where it had been broken down. In places this debris was piled up 30 ft. high.

Then came a big struggle at law between the agricultural and mining interests. It was decided that the alluvial mines could continue work so long as they did no material injury to the navigable streams or the lands adjacent thereto; but as this was practically impossible, these mines had to shut down.

This hydraulic industry is reviving in the northern part of the state, where there are big banks of gold-carrying gravel. In this locality the rivers are strong enough to carry away all the debris produced.



A DREDGE WORKING AT OROVILLE, CALIFORNIA

The gold-dredging industry of California, especially in the Oroville district of Butte Country, has become important, and is now on a sound basis.

In 1904, 8 per cent of the gold output of the state came from dredging, or, say, \$1,500,000; and this figure is likely to increase.

The Oroville field is reckoned to have a dredgable area of 5000 acres, and as much as \$3000 an acre has been paid for some of the richest ground. The gravel averages over thirty feet deep; the boulders are not unduly large, and there is a soft bed-rock.

The average value of the ground is put at about 15 cents a yard, which is a fairly high figure for dredging. The total costs, including depreciation, amount to about five cents a yard, or equal to one third of the gold won. I consider this area is the safest dredging-ground yet discovered, and expect it to be highly profitable.

The mines of Utah, Montana, Arizona, Oregon, and Idaho, being mostly owned locally, and, in many cases, as private concerns, do not call for extended notice.

Alaska. In the year 1867, when the American Government bought Alaska and its islands from Russia for \$7,200,000, a big party in the States was opposed to the purchase. In those days Alaska was looked on as almost uninhabitable; and if one reflects on the small good Russia had got by holding it, and were to take that fact as a criterion of its real value, the argument of those against the purchase was not so weak as it might now appear. Since that time the value of furs, fish, and timber produced by Alaska, to say nothing of minerals, has yielded back the purchase price many times over, and every year since 1900 the output of gold has exceeded the figure of the original cost of the country.

South-eastern Alaska, the narrow strip of land running up the west boundary of British Columbia, with its inland seas and thousands of islands, is a region full of minerals and with unique facilities for cheap mining. These mining facilities are: water

power for at least the greater part of the year ; wood for timber, or fuel, on the spot ; water transit for the high-class coal from Vancouver Island ; natural grade for moving the ore from the mine to the mill, and for getting rid of tailings ; and bodies of ore that are usually above the normal in size.

The ores found in this region carry either gold, silver, or copper, or all three. The mines as a rule are on one or other of the many islands, as the mainland, owing to the density of the forests and the presence of large areas of glacier on the mountains, has not yet really been prospected.

At Ketchikan, Prince of Wales Island, Sumdum, Berners' Bay, and other points along the coast, small mines have at one time or other been worked, mostly for gold. At none of these centres has anything of much solidity yet been found.

The two remaining centres, Juneau and Douglas Island, are the largest quartz-mining districts in Alaska ; Juneau is on the mainland, lying in the shadow of high mountains, while two miles away, on the other side of Gastineau Channel, is Douglas City and the Alaska Treadwell group of mines.

In 1880 placer-mining began in the mountains behind Juneau, and in 1881 on Douglas Island. This island is sixteen miles long and eight miles broad at the centre. It is simply a mountain range standing out of the sea ; the lower slopes are covered with fir-trees, and the drainage of a tremendous rainfall flows down from the heights.

The placer workings, started in 1881 on the beach of Douglas, led up almost at once to a wide gold-bearing formation outcropping on the slope of the mountain only a few hundred feet from the sea-shore. On this lode the Alaska Treadwell, Alaska Mexican, and Alaska United are now running 880 stamps, and their open quarries extend along it for more than a mile.

This immense lode was in one place at the outcrop over 400 feet wide. It is in many other places along the surface 100 feet wide, and even at a considerable depth is found to be 80, 100, or even as

much as 150 feet wide. Here and there, where the slate walls press in, it narrows to a mere stringer, and loses, too, much of its area by the intrusion of bodies of slate and diorite; but in spite of these contracted parts its bulk is truly colossal, and its continuance in depth seems assured.

The lode is a dike of granite, altered to or highly impregnated with quartz, and carrying pyrites. It is free-milling as to about 60 per cent of its gold, and as the pyrites concentrate perfectly, it may be called an ideal ore to treat. As to the exact dimensions of the lode, it is difficult to define these. Its width we know, also the fact that it is going right down; but its length is not defined. It runs almost parallel with the beach, and is dipping under the sea at an angle of about forty-five degrees. This holds good for nearly two miles in length; but at each end there is a blank and not enough work has yet been done to show what really happens beyond these points. Perhaps the slate walls simply close in again, leaving no sign of the great fissure, or maybe the lode continues on—but in a less metamorphosed condition. In this case its granite origin would show more clearly than its more recent quartzose structure, and naturally the free gold and pyrites would tend to disappear. In any case, it may be noted that in the east end of the Treadwell and in the west end of the United—these points marking the extreme working along the line of reef—the lode shows itself badly defined and with hardly any value; but these companies will have for years too much on hand to take up the costly work of exploring for doubtful extensions of the lode beyond these points.

At work along the line of this lode are the Alaska Treadwell, Alaska Mexican, and Alaska United. These mines are treating, all told, over 3000 tons of ore a day, and making a profit of about 30 cents a ton; the value of the ore is rather over \$2 a ton. As these are figures with which other mines in the world cannot compare, I propose to show at some length how they are arrived at.

Douglas Island is an ideal mining field, and a record in cheap working was indicated from the commencement.

Firstly, there is a great body of ore. This always means cheap

mining ; and in addition it is an ore easy to blast down and also to crush in a mill. If the ore were rich it would all have to be taken out—which means a heavy cost for timbering ; but as it is of low value, large portions can be left in for pillars without any cost and at no great loss.

Secondly, the ore is easily treated ; something like 60 per cent is saved in the mill as free gold, and after the tailings have passed over frue vanners, on which the pyrites are concentrated, hardly any gold is left in them.

Thirdly, the tailings run direct into the sea, and are swept away by the tide—disposing, naturally, of what is often an awkward problem. In the same way the fall between the mine and the mill saves labour in handling the ore.

Fourthly, there is water power—at least, in the case of the Treadwell—to drive most of the machinery for all the year, and the whole of it for about eight months. Elsewhere in Alaska the water usually freezes in winter, but on Douglas Island it runs perennially. Water power also produces electric light for the mines, above and below ground, and compresses air to drive an aggregate of about sixty rock-drills.

Fifthly, there is water transit to the mines, and a deep-water wharf within several hundred yards of the shafts. This ensures cheap carriage of supplies from the south ; it is especially valuable for the bringing in of shiploads of the fine coal mined on Vancouver Island, and for the despatch in the empty coal-steamers of concentrates to the smelter at Tacoma.

When to these unique facilities is added the best American work in mining and labour-saving, one begins to realize that the *ne plus ultra* of gold-mining is not far from being reached.

The **Alaska Treadwell** section of the lode was in one place on the surface over 400 ft. wide, and in the beginning the mine was worked extensively as an open quarry. Below the quarry the ore is worked in the ordinary way by shafts and levels—the lowest level at the present time being at 900 ft.

The blocked-out ore above this lowest point is placed at 4,000,000 tons, but if the 900-foot level were driven to the boundary, no doubt the reserve would figure at nearly 5,000,000 tons. The recovery value from this may be placed at nearly \$2 a ton.

A considerable proportion of this ore is not available for use. Timbering and stope filling, on such a wide vein, where the values are so low, would eat up the profit; so, instead, large vertical and horizontal pillars of ore are left standing. When the mine is worked out in depth, it will be possible to extract some of the ore now left in as pillars; but probably one-quarter of the current reserves, and a gradually increasing proportion as time goes on, should be written off as not recoverable.

The probable ore in the mine, below the bottom level, is a debatable point. I believe there is not so much as is supposed. No doubt the quantity, whatever it is, runs into millions of tons; but where one is dealing with ore which only yields, say, 75 cents, or 3s. a ton profit, a million tons makes no great impression. The reason for my belief as to the mine's future in depth will be more apparent if the longitudinal plan of the ground is inspected. It will be seen that at each level the limit of the payable ore extends farther and farther west, and that in the bottom of the mine the length of ore worked is not nearly what it was on the surface.

In other words, the pay-chute, instead of going down vertical, is dipping obliquely across the mine, and at each level the length of payable ore, and consequently the tonnage, is falling off.

It is possible that at a greater depth the course of the pay-chute may alter, and dip again into, instead of out of, the mine, or a new make of ore may be found in the east end; but there is, so far as I know, no evidence to justify these surmises.

The Alaska Treadwell has 540 stamps, in mills of 300 and 240, but for four or five months in the year, owing to lack of water power, the 300-stamp mill does not run. The ore crushed varies from about 30,000 tons per month in winter, with 240 stamps, to about 85,000 in the autumn, with 540 stamps, when the water supply is at its maximum.

The 300-stamp mill of the Treadwell is the most efficient in the world, for each stamp can crush over five tons of ore a day for about 12 cents a ton. The ore is brought into the top of the mill by a small engine and the cars discharged automatically into a bin which holds 3000 tons. It then passes through challenge ore feeders into the mortar-boxes, where it is crushed by 1020-lb. stamps. There is box amalgamation. The crushed pulp then passes over a 12-ft. copper plate on to a 6-ft. broad frue vanner—two vanners to each five stamps—and from there direct into the sea, where it is dissipated by the tide.

The work of the frue vanners on the ore of Douglas Island is wonderful. There are, in all, 352 vanners. At the Treadwell the tailings are supposed to assay not more than 20 cents a ton, showing an ideal extraction.

The concentrates represent about 2 per cent of the total crushed ore passed over the vanner; they are shipped to Tacoma, where they are smelted.

The last issued report—to May, 1904—shows the following results for the year:—

Tons crushed	.	.	.	.	775,150
				\$	\$
Yield per ton	.	.	.	2.44	1,895,084
Total costs	.	.	.	1.37	1,064,584
				Net profit	1.07
					830,500

The costs were distributed as follows:—

				\$
Mining and development, per ton	.	.	.	.97
Milling	.	.	.	.15
Treatment of concentrates	.	.	.	.14
Sundry	.	.	.	.11
				1.37

This yield of \$2.44 per ton, and corresponding profit of \$1 per ton, is, I estimate, above the value of the ore rem



THE 300-STAMP MILL AT ALASKA TREADWELL

in the mine, on which I do not allow for a greater average profit than 75 cents per ton. In the earlier years the average yield was over \$3.50. In 1892 it fell below \$3, and the trend since then, though gradual, has been downwards. In placing the future yield, one year with another, at \$2, and the profit at 75 cents, I believe I am not wide of the mark.

A valuation of this mine, on the recognized lines, will show that the shares stand above their true value. If it takes one ton of ore to make 75 cents, or 3s., profit, it will require over 9,300,000 tons to pay back £7 a share, which is the present market valuation of the mine. I am not prepared to assume that there is so much available ore as this in the mine. If due allowance for current interest on the capital invested is also made, the tonnage to be worked would require to be much more than this. Against this, however, the considerable cash reserve of the company would assist. The company's holding in the Tacoma smelter was recently sold, realizing a profit of over \$1,000,000. This money is being paid away as bonus; but such payments, which are transient, must not be confused with profits from working the ore.

I place the net profit at present in sight, including (a) Available ore in the blocked-out reserves, (b) Cash and stores on hand, (c) Cash representing undistributed proportion received from sale of smelter, at about £750,000. This represents slightly over 50 per cent of the market valuation of the mine—a disproportion which on a low-grade mine of this nature is not justified.

It has finally to be said in favour of the Alaska Treadwell Company that before its own mine is worked out those who control it will no doubt have purchased or developed one of the great low-grade deposits over on the mainland, by means of which they may be able to perpetuate their present good work.

The **Alaska Mexican** is a Treadwell on a smaller scale. The reef is the same, except that it is narrower and more disturbed than in the Treadwell; it is mined in the same way, and the mill and frue-vanners treat the ore with as good results: the battery is also built

close to the sea, and the tailings are carried away by the tide. The ore is of rather better value than Treadwell—\$2.5 a ton, and working costs are only slightly higher than at the bigger mine.

The Mexican has 120 stamps, which crush now over 200,000 tons a year, and by rights ought to have 1,500,000 tons of reserves. But there is nothing like this quantity exposed. The reef in this mine is badly squeezed in many places, and although it opens out to as much as 100 ft. wide, its bulk cannot be compared with the Treadwell. The really sound feature about the mine is that the ore in the lowest workings, both in size and in value, shows practically no falling-off.

The usual water power is installed, which drives the mine machinery most of the year, and generates electricity and compressed air all the year. The company gets its coal and ships its concentrates in the same contract as the Treadwell.

The Mexican should have a fairly successful future. But of course, until much more ore is in sight, the holder of the shares has not got the security which a mine of this size should be made to show. On a strict basis of valuation, the shares are too high.

The **Alaska United** has got 220 stamps. The mine is worked similarly in all respects to the Treadwell and Mexican. The ore is, however, worth less than \$2 a ton, and practically no profits are earned.

The property of the Alaska United is the most westerly spot along the line of the lode that has yet been proved. Here the reef bulges out again to quite 150 ft. thick, but the effort does not last, and a length of 400 ft. seems to exhaust the payable ore. Although the value of this mine is under the average of the others, the size of the reef in depth seems to hold good. Here an incline-shaft is sunk on the footwall of the reef, and is already out under the sea.

The method of mining the ore in these Douglas Island properties is, so far as I know, original, although it has now been adopted at Camp Bird, and in several of the West Australian mines.

Owing to the low value of the ore, the expense of heavy timbering

and stope filling, such as a deposit of this great size requires, would eat up the greater part of the profits. The alternative course is to leave in blocks of the ore as pillars. This is possible only where the formation is solid, and the walls of great resisting power, which, fortunately for the Douglas Island mines, was found to be the case.

The ore pillars left in are vertical and horizontal. The vertical pillars, where possible, are left where poor patches of ore occur. The horizontal pillars, from fifteen to twenty feet thick, are left over the top of each stope.

The next step is to stope the available ore. As this is broken, one-third is drawn off; the miners mount their machines on the top of the broken ore, which always reaches to within a few feet of the roof of the stope, and keep moving upward, with the broken ore collecting below them, till the horizontal pillar at the top of the stope is reached. This broken ore is further reduced by "bulldozing" to a convenient size.

Where the reef is of great width, a single stope may contain several hundred thousand tons of broken ore, which, without further handling, is drawn off automatically into trucks below. If the width is excessive, two parallel drives run under the stope, and the ore empties itself through two series of doors.

When a stope is emptied, and it is seen that the walls are standing well, parts of the vertical ore-pillars left in may then be blasted down. At a later stage, when the mine is exhausted, it may be feasible to take away a large proportion of the ore now forming the vertical and horizontal pillars; but I imagine that at least 25 per cent of all the ore in the mine will, under this head, not be recoverable.

Over against Douglas Island, on the mainland, is the town of Juneau.

Up in the mountains behind, there is another immense gold-bearing formation, which can be traced for some miles. It is a slate formation carrying seams and stringers of white quartz all

through it, and is much wider than the lode on Douglas Island. Half a dozen small mines have worked, or are now working, on this formation with from ten to thirty stamps, picking out sections on the footwall where the quartz shows in bigger bunches, and presumably paying expenses. But this is mere fencing with the ultimate solution, which I take to be the quarrying of the whole mountain sides through which the formation runs, and feeding several hundred or a thousand stamps. The facilities are great; there is abundant water power for most of the year, a fine natural fall for handling the rock and getting rid of tailings; and the ore is free-milling. As regards the essential fact—the value of the ore—I have seen assay plans of big areas of the ore which show at least a gross recovery value of a dollar a ton, and my interest in the future of this great deposit was increased when I found that ore yielding a dollar, if worked on a sufficiently large scale, would pay well.

The mine which should be the first to prove the actual value of this formation—taking everything and working as an open quarry—is the **Alaska-Juneau**. This property belongs to the group which controls the Treadwell mines; it is under the same management, and its thirty-stamp mill, driven by water, is now being used to sample big patches of the ore quarried out at different spots on the side of the mountain.

Here are the figures for the month preceding my visit to the mine—from ore taken from one given area, and constituting a test of the value of that particular part of the mountain.

RESULTS FOR MONTH OF AUGUST, 1901.

Tons crushed	.	.	3568
Yield per ton	.	.	\$1.26
Costs per ton :—			
Quarrying	.	.	.60
Milling	.	.	.22
General	.	.	.22
			<hr/> 1.04
Profit per ton	.	.	\$.22

It is easy to see that if this mine could be run with 400 stamps, working costs would not be more than 60 cents a ton, and I think the series of tests show that there are millions of tons which will give a yield of a dollar. I foresee that the Alaska-Juneau will buy up some of the adjoining ground to get a better outlet for its tailings, and a bigger head of water for driving machinery. Some day it will probably be reconstructed with enough capital to erect 400 stamps. This would make a most interesting mining problem—and I think a profitable one, although the first outlay would of course be enormous.

It will be noticed in this cost-sheet of the Alaska-Juneau, that there is no charge for concentrating the ore. Frue vanners were put in; but as the concentrates produced were only worth \$20 per ton, and as the cost of production—cartage down to Juneau, ocean freight, and smelting—would have absorbed all of this, the idea of concentrating was abandoned. The tailings contain from 30 to 40 cents, but it is cheaper to let this go away, and to rely on the mill only for recovering gold.

Another mine on this line that would probably do well if worked on a very big scale is the **Alaska Consolidated**. Its owners have however, begun badly; for they have equipped it with a large watered capital and a small amount of cash. For a low-grade mine of this sort, if serious mining is contemplated, a reversal of this procedure is the wiser course.

It is reported that this mine—or mountain, for it really has the area of one—carries ore averaging over \$3; but I look on this figure as excessive. If there is a value of \$1.5, and enough money is put into equipment, such a mine might easily become a second Treadwell.

I believe that for the genuine mining capitalist, who knows how to lay out a great deal of money on a low-grade mine, the Juneau district is one of the choicest spots in the world at the present time.

The alluvial fields of Alaska proper continue to produce a lot of

gold ; and if some of the older centres—notable Cape Nome—show a falling-off, there is now a much wider district being explored than formerly. In the interior the Koyukuk and Tanana rivers and their tributaries have turned out a number of alluvial fields, while the lately discovered Fairbanks district, off the Tanana, is probably the best alluvial field yet found in the interior of Alaska. North of the Yukon River much of the country is still unexplored.

CHAPTER XIV

THE GOLD-MINES OF CANADA, MEXICO, AND CENTRAL AND SOUTH AMERICA

Canada. Since the year 1900 the output of gold in Canada has been falling: the estimated yield of 1904—£3,371,000—shows a decrease of over £2,000,000 sterling from the former date.

This has been mainly due to the falling output from the Klondyke district; but there has also been a decrease in British Columbia, Nova Scotia, and Ontario, and as no new mines of much note are being opened, there is small expectation of any immediate improvement. The Yukon territory, including Klondyke, is still the largest producer; but its output, which was over £4,500,000 sterling in 1900, was less than £2,000,000 in 1904. This is from alluvial workings only; there are no quartz-mines in the Yukon.

British Columbia has both alluvial and quartz-mines. Hardly any of these are genuinely profitable ventures, but among them they turn out a lot of gold. The Rossland field is still the backbone of quartz-mining in Canada, but has now come down to a low-grade basis.

Ontario is a failure where its gold-mines are concerned. None appear to be working at a profit.

Nova Scotia remains only a small gold-producer, and the outlook there is not assured.

Taking the gold-fields in detail, from east to west, it is to be noted that in 1904 the output in Nova Scotia had fallen to about £38,000, the lowest for many years. This was equal to 16s. a ton,

and, as the lodes there are narrow, must have been produced at a loss.

Assuming the reefs to be of the anticlinal formation, and that, as at Bendigo, a series of saddles will be met with, several deep shafts are now being sunk, in which work the local government is giving financial assistance. Should these give good results, British capital would no doubt be available for further development, but at present there is not enough inducement offered.

Ontario hardly merits separate notice as a gold-producer. In the eastern districts several small mines, such as the **Belmont**, turn out some gold, but any profit they make is from the arsenic in the ore.

The Lake of the Woods district seems to have quite failed, and such mines as **Mikado** and **Black Eagle** have earned no profits.

In the North-Western territories some dredging is being done along the Saskatchewan River.

British Columbia has been uniformly disappointing as regards its gold-mines. This is not because of lack of gold, but rather, as in Rhodesia, because the gold is rarely concentrated into a commercially profitable deposit.

This is a country which will turn out a good deal of gold for many years, even if no net profit results; while the gold yielded as a by-product by some of the copper-mines is also an asset of value. It is to be noted, in the country's favour, that an immense territory, equal to nearly 300,000 sq. miles, has never yet been fairly prospected. This, in course of time, should at least produce a great deal of alluvial gold.

There is now little quartz-mining in British Columbia outside the Rossland field. This field has now to face the future on a low-grade basis, as nearly all of the richer ore is exhausted. It is questionable whether, on such a basis, profits can really be earned; for the ore here is complex, carrying copper and silver as well as gold, and the treatment of this ore, by smelting, is a costly process. I believe that no mine at Rossland, not owning its own smelter, can work at

much under 45s. a ton, and I doubt if there is any mine on the field with an appreciable amount of ore left in it of such a value.

It is possible that a metallurgical process might be evolved which would effect a concentration of the metals in the ore without the necessity of smelting ; but it is a remote contingency to figure on. To my mind, it is obvious that the only hope of these small individual mines, from the economic point of view, is that they should lose their identity—an identity which entails the heavy costs of separate management and equipment—and become merged into two, or perhaps into one large consolidation. The bases of such amalgamations rest in the two smelting plants, one of which belongs to the Le Roi Company, and the other, I believe, to the Canadian Pacific Railway. These plants represent a big capital expenditure, and their joint possession by all the mines of the field would allow of a considerable all-round reduction in expenses. A reconstruction of all the Rossland mines into, say, two concerns, each owning a smelter, or, perhaps, preferably, into one large consolidation, would appear to be the best solution of the economic position.

The basis of this consolidation would be the **Le Roi** mine, because of its valuable smelting plant. If the amalgamation were to lead to so substantial a reduction in costs that a very great tonnage of exposed ore would be brought into the payable horizon, the other smelter could also be acquired ; but that is a matter that would be determined when the mines were being re-valued.

The Le Roi, as a mine, is now low-grade, and probably will not yield a large amount of payable ore. The **Le Roi No. 2** ought also to be included, although it too has probably no rich ore left. It is doubtful whether the **Rossland-Kootenay** would be worth buying for the consolidation ; the price paid, in any case, would be small. The **Velvet-Portland**, a mine some few miles from Rossland, with a small amount of good ore at present exposed, should be taken into the amalgamation.

As regards the Canadian-owned Rossland mines—the **War-Eagle**, **Centre Star**, and **Iron Mask**, these would also find it to their economic advantage to join such a consolidation. The first-named is still

earning profits, even without its own smelter, and is perhaps the most hopeful mine on the field. The Centre Star has big, though low-grade, ore-bodies.

I feel sure that a consolidation, of one sort or another, is the only way to make this field, on its present low-grade basis, yield any profit at all. If eventually a cheaper process than smelting enabled the ores to be worked to better advantage, even then the argument would still hold good, for a strong concern is always in a position to dictate better terms for itself than a weak one.

In advocating a present consolidation of the Rossland mines, I do not want it to be assumed that these will be necessarily profitable, even if amalgamated. A preliminary inquiry into their position, and their re-valuation, on the basis of ore exposed, might demonstrate that a number of them would not yield profits on any terms at all. It might be found that even if, by amalgamating, expenses were reduced, they would not be reduced sufficiently to bring the greater part of the exposed ore into commercial use; and it might also be proved that the total of exposed payable ore on the field did not justify the trouble and hostility which an attempt at consolidation would entail. But if, on the other hand, a preliminary inquiry showed that such a thing were justified, common sense ought to step in and carry it through.

The quartz-mines in the Nelson district are disappointing. Of these the **Ymir** was at one time a valuable property, but in depth has become poor. The others are shut down.

Of the alluvial mines in the Northern districts, the most interesting is the **Consolidated Cariboo**, a Toronto company. It is estimated that the gravel-beds owned by this concern amount to 500,000,000 cubic yards. At one time the average of the gravel treated was 9d. a yard, but it seems unlikely that this figure will be maintained. In 1904 the yield was barely 3d. a yard, and the receipts and expenditure just balanced. In that year, however, the gravel was sluiced mainly from the upper, and therefore poorer, part of the deposit. This



HYDRAULIC SLUICING AT ATLIN, BRITISH COLUMBIA

company has spent a large amount in securing a water supply, and is over £100,000 in debt. Up to the present, the results have been disappointing. One drawback has been the scarcity of water, which, by spending more money, can no doubt be overcome. The hardness of the gravel, entailing a big expenditure for blasting, is turning out a more serious factor. On the whole, however, it is to be expected that this mine will do better in the future than it yet has done. The **Slough Creek** Company, also a gravel-mine, is thought to have favourable prospects.

In the Atlin district, the English-owned sluicing mines, the **Atlin**, and **Atlin Lake**, have not done any real good. Elsewhere on this field several American-owned claims have given better results, and dredging may be introduced.

About 1300 miles up the Yukon River, in a country formed of alternate ranges of hills and water-sheds, and generally covered, except on the hill-tops, with forests of stunted spruce, birch, and poplar, there are two tributaries, the Klondyke and Indian rivers, which fall into the Yukon about twenty miles apart. Between these small rivers the country rises to a high ridge, with an elevation of 2500 feet above the Yukon, and from each side of this ridge flow a number of creeks towards one or other of the rivers. Flowing into the Klondyke, either direct or after junctioning with other small creeks, are Bonanza (where the first discovery took place), Eldorado, Bear, Hunker, Last Chance, and Gold Bottom creeks. On the other side of the divide, flowing into the Indian River, are Dominion, Gold Run, Sulphur, and Quartz creeks. The whole of these lie in an area about twenty miles wide and forty miles long, which is bounded on three sides by the Yukon, Indian, and Klondyke rivers, and known as "The Klondyke." Over nearly the whole of this area the rock is a coarse talcose schist. Its strata lie irregularly, and in places eruptive masses of diorite and diabase break through. Everywhere the quartzose nature of the schist is marked, and veins of solid quartz run through the whole mass. The creek beds, which vary in width from perhaps a thousand feet at

their lower ends to fifty feet, or less, near their source, carry a layer of gravel from a foot or two to twenty feet thick, which in turn is covered with a layer of black bog clay.

But large as is the quantity of gravel lying in the creek beds, an equally great amount is found on benches on the hill slopes, lying at as much as 300 ft. to 400 ft. above the levels of the creeks. These "bench" or "hill" gravels, like those in the creeks, contain quartz boulders of all sizes, and are often just as rich in gold. The gold everywhere is mostly contained in the lower foot or two of gravel, and much of it has sunk into the schist itself, which in places is decomposed to a depth of several feet. The remainder of the gravel, which on the hill benches is sometimes 100 feet thick, is nearly valueless.

The gold is not evenly distributed on the gravel bottoms. There is always a "pay streak" carrying more than the rest, which may vary from a few feet up to 300 ft. in width.

In the Klondyke of to-day the "pay streak," or, in other words the richest gravel, has been pretty well exhausted. This is not a matter of argument, but is demonstrable by figures. The field was discovered in 1896; by 1900 the output reached the high-water mark of nearly £4,600,000, and it has gradually fallen since; the 1904 output was under £2,000,000, and each year is likely to show a further fall.

The exhaustion of the richer gravels is to a certain extent compensated by cheapening in methods of handling, bringing more and more material within the zone of payability. The use of steam scrapers for shovelling the river-bottoms and for open-cut work generally, and water conservation by building dams, have assisted to cheapen handling. As example of this, some of the richer gravel worked in the earlier days is now being reworked at a profit.

Of course, cheap handling of gravel at Klondyke is a relative expression; for wages and supplies, owing to the extreme cost of transport, must always be heavy items. Still more serious than this is the scarcity of water for ordinary sluicing, and the absence of any water at all for natural hydraulic work. There can be no com-



DAWSON CITY, KLONDYKE, IN WINTER

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parison of the Klondyke gravels, which must be shovelled by the most expensive hand-labour in the world, with those of, say California or New Zealand, where all the work is done by hydraulic power. The so-called "poor" gravel at Klondyke, which I suppose will never be touched at all, and of which there is a great bulk, would be looked on as rich in California, and worth some million pounds.

Several attempts at artificial hydraulicing, by pumping water against the hill-gravels from the creeks below, have been made, but the costs, except where the very richest patches were concerned, have been prohibitive. A scheme for pumping on a big scale from the Klondyke River to such a height above the richest creeks as would give sufficient pressure for hydraulicing has been discussed. This question, however, involves so much money and so many legal and other problems, that it could only fittingly be undertaken by the Government, and that only after prolonged inquiry.

It is said that one of the creeks now running into Indian River, if diverted, would furnish such a head of water as to permit of hydraulicing a big area of the gravel deposits. If this could be done, the life of the field might be prolonged for a number of years; and the scheme is well worth close inspection; but here again the Government should preferably take the question in hand.

The English-owned mines at Klondyke have been failures, and most are now gone into liquidation. The **Anglo-Klondyke** has earned some profit, and may have the material for one or two more seasons' work; but on the estimate I made when inspecting the mine in 1901, it must be nearly exhausted.

The **Klondyke Government Concession** has a big area of gravel on Hunker Creek, and, at the time, I thought it might pay if worked on a big scale. So far, however, it has failed to materialize. A considerable capital expenditure would no doubt be necessary before steady profits could be earned, and it may be that prospecting would demonstrate that this was not justified.

The prospects of the **Bonanza Creek** Company are speculative.

There are no reef mines at Klondyke, nor, in my opinion, although valueless quartz stringers are frequently visible, will there ever be. People talk of a "mother lode" from which all the gold in the gravels has sprung; but there is no reason to believe in the existence of such a phenomenon. On the contrary, there is every reason to believe that the gold existed in a great volume of low-grade quartz, and that it is to the subsequent erosion of this quartz and the concentration of its metal contents that the wealth of the Klondyke is due.

The other districts of the Yukon have so far failed to show the elements of permanence.

Mexico. Mexico, as a metal-producing country, is expanding a good deal. It is at present the biggest producer of silver in the world, and its output of copper and lead is going up. As to gold, it produced, in 1904, £2,197,000, much of which was a minor product from the silver and copper mines.

As yet, outside the El Oro field, there are not many true gold-mines in Mexico. Silver, since the days of the early Spaniards, over 300 years ago, has been the more sought after metal, and it is possible that a systematic search for gold-ores in a highly mineralized country such as this, would lead to the discovery of valuable deposits. Such a search will be facilitated by the present activity in railway building.

Nearly all the Mexican mining-fields lie in, or adjacent to, the main range of the Sierra Madre. Much of this country, owing to lack of communication, has never been prospected, but there seems every reason to expect that such states as Chihuahua, Sonora, Lower California, Sinaloa, and Durango have probably still great hidden mineral wealth. As to whether the complex type of deposit will predominate over all those districts, rather than the gold-bearing ores, can only be a surmise. Some engineers consider the State of Oaxaca as likeliest to produce gold-ores, and a good deal of American capital is going there for prospecting work.

The principal gold-field in Mexico is at El Oro, in the State of Mexico, which has the makings of great things.

The basis of this field is a main lode of great width, running continuously for two miles; it is often fifty feet wide. There is also a series of smaller lodes running parallel with this.

On the main reef are located the El Oro, Esperanza, Mexico, and Carmen mines. These cover a distance of two miles, through which length the reef runs interruptedly. It continues beyond these limits, no doubt, but because of the deep capping of andesite—volcanic overflow—which covers the country, it has not yet been traced. The value is in gold, except as to about one-tenth, which is silver.

The best mine off the main lode is Dos Estrellas, and the Victoria y Anexas is promising.

The facilities on this field for cheap treatment are good. The altitude is over 7000 feet, and the climate healthy. There is water, wood fuel, timber, a railway, a natural fall for the surface works, a superior class of native labour at a low wage, large ore-bodies, an ore amenable to ordinary treatment, and payable values spread over biggish areas.

The main El Oro vein, down to 500 feet, has contained a great deal of gold—so much, indeed, that one doubts the probability of the gold continuing in such quantity to a much greater depth. As if to bear out this, the deepest workings in the two principal mines show a falling-off in value, which, should it continue, will seriously affect their future. It is possible that this is a local impoverishment only, due to the change from oxidized to sulphide zone; but it is more probable to assume that this master lode is beginning to share the fate which sooner or later must overtake all such deposits. The exhaustion of payable ore on the main lode, even under the least favourable conditions, will take a number of years. By that time further exploitation ought to have located good ore either on the extensions of the main body or on some of the parallel reefs, for the possibilities of this field beyond its present known values seem to be considerable.

The El Oro Mining and Railway Company is now working 200 stamps, and on the main lode has exposed ore-reserves of probably 800,000 tons. In the upper levels a large quantity of rich ore existed, in places being as wide as forty-five feet; this has now been mostly exhausted. In the lower levels the values have fallen off considerably, and at the time of writing this are not payable. As to whether this is a temporary falling-off in value, due to the passing from oxidized to sulphide zone, is not yet determined; but so far as the main lode is concerned, the evidence is not favourable. The mine is of large area, and in the course of development at the shallower levels, further big blocks of payable ore are likely to be met with. These, in addition to the ore already in sight—assuming that the lower levels show no improvement—should keep the mill at work for a number of years. The profit per ton in future will be much smaller than in the past, but as the quantity treated will be doubled, an annual profit of over £200,000 should be maintained for some years.

The chances of finding good ore on one or other of the parallel veins on the property are hopeful, although not so good as they were some years ago; the likeliest spots are the extensions of the new Esperanza chute and the Victoria y Anexas, in which mine, at a distance of only several hundred feet from El Oro boundary, a rich chute was cut.

The El Oro holds an eighth interest in the adjoining Mexico mine, which is likely to become an asset of some value.

A further asset is its railway of thirty-two miles, connecting the mines with the main line; this also runs to its timber concession, which supplies the mines with fuel and timber. This railway and concession form together a valuable holding.

Another item of value is the large quantity of residues and slimes amounting to several hundred thousand tons. By a system of finer grinding it is expected that these will yield a good profit over the cost of re-treatment. As to the precise net value of the ore-reserves there are in the meantime several factors at work which make it hard to arrive at this. These factors tend to a cheapening



EL. ORO MINE, MEXICO

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of working costs—as, for example, the recent doubling of the mill, and the installation of electric power. Also to be noted is the finer grinding of the ore, which will tend to raise the cost of treatment, but will give a better extraction than formerly. Taken altogether, including the residues on hand, I suppose the present ore-reserves will yield at least a profit of £650,000. To this add £150,000, as value of the railway and the timber lands, and say £20,000 as the value of the Mexico shares. Altogether these items amount to £820,000. With the shares at £1, this is equal to 76 per cent of market value; but it must be borne in mind that until the bottom of the mine improves, or good discoveries are made elsewhere, the future is not fully assured.

Adjoining is the **Esperanza**. This was acquired from the local owners two years ago, and is now held by British and American shareholders. At the time of purchase the net profit in sight represented about 70 per cent of the capital, and the appearance of the mine in depth was moderately good. In addition, the purchase price included a good equipment and 120-stamp mill.

In the first year things went wrong, unexpectedly. In the mine, at the new level driven, the ore became poorer. A big “crush” also took place, which cost a lot for repairs to shafts, and for timbering generally. Exchange also went up, and the price of fuel. The net result was that while the grade of the ore, which included the poorer ore coming from the deepest developments, tended to fall, the expenses rose definitely by several shillings a ton; and the proportion of profit in sight, which at the time of flotation had been 70 per cent, fell to below 40 per cent.

When at the worst, a remarkable change came about. The ore in the bottom did not materially improve, and at the time of writing this is still not good; but boring horizontally with a diamond-drill exposed two new reefs, each of which, when driven into, turned out to be of exceptional value.

So far as can be determined, these new lodes, or rather such parts of them as are payable, are not of great extent; for further boring, both on their extensions and dip, have failed to locate good values

far from the area being developed. But where payable they are certainly very rich indeed. The first 15,000 tons blocked out showed a net profit equal to the whole of the rest of the ore exposed in the mine; and as it is reasonable to expect that not less than 30,000 tons of this rich ore exist, it can be seen that the future of the mine has benefited greatly by these discoveries. A curious thing about these new lodes is that the ore is sulphide, whereas on the main lode, at the same depth, it is still oxidized. It is possible that this is a good indication for the value of the main lode when it shall have been developed in the sulphide zone. But of this I am sceptical. Both in El Oro, Esperanza, and El Carmen, a marked falling-off shows in the main lode below 500 ft., and I think the weight of evidence is rather against any definite improvement setting in at a still greater depth.

The position of this mine at present is most interesting, and on the ore exposed it must do very well for three or four years. Beyond that the future will depend on the value of the main lode in depth, and upon the extent of the lately discovered parallel veins. The inference is that these are limited in area, but this may not prove to be the case. The company will benefit by adopting electric power; but so much timbering has now to be done, as the result of the "crush," that the previous low standard of costs will hardly be again reached. As more of the rich ore becomes exposed, a re-valuation of the mine, on the basis of profit in sight in proportion to market valuation, will be necessary. Any one making this for himself must also bear in mind the condition of the lowest workings on the main lode.

With the shares at 21s. the profit in sight at the date of the last report was equal to 70 per cent of market valuation, but the new developments will make an early re-valuation necessary.

Mexico Mines of El Oro. This property is on the main lode, and is the direct continuation of the El Oro-Esperanza line. As stated, the El Oro Company has an interest in this mine, and it is intended to set aside some of the El Oro stamps to work the ore from it. At a recent date, 70,000 tons of ore of good value had been exposed.

The future of the Mexico will not be assured until its workings have passed the critical depth at which the El Oro and Esperanza have become poor.

The Carmen mine, belonging to the **British Gold Mines of Mexico**, was good to about 500 ft. in depth, and then went wrong altogether. On the 650-ft. level I saw a fine reef, 20 ft. wide in places, but quite unpayable. It seems improbable that this mine will again improve in depth. The mine is now shut down.

The principal mine not on the main lode is **Dos Estrellas**. This is on a parallel lode half a mile distant. Where first cut, in an adit tunnel, at 650 ft. below the andesite capping, the lode was 45 ft. wide, and of payable value. Subsequently some exceedingly rich patches were met with, and the ideal of the local owners seems to have been to work the mine in the hope of a recurrence of these patches rather than as a low-grade venture. It seems to me that this property has the making of one of the big low-grade mines of the world. But first of all it requires systematic development, and the spending of a large sum on equipment, and I imagine that its local owners are prepared to give it neither of these. Worked on a small scale, for its richer ore, it may turn out a fine mine; but on the other basis it may possess the elements of greatness.

The **Victoria y Anexas** is adjacent to Dos Estrellas, and carries either that lode or a parallel. When I was last at El Oro a rich ore-chute had been located at 200 ft. deep in this mine, and it certainly has possibilities. This property is owned locally.

At Minas Prietas, in the State of Sonora, the **Creston and Colorado** has been a large producer of gold, but has probably a limited life now. The adjoining mine, **Grand Central**, owned in Britain, is now worked out.

In the State of Chihuahua are the **Palmarejo** and **Dolores** mines. Each of these carries value in silver, almost equal to the gold. The first-named promises to become a large low-grade mine. The

latter is small, but extremely rich. It has profit in sight to the extent of several hundred thousand pounds, but the reef is narrow, and it would be unsafe to value the mine at more than the net profit exposed at the time.

The **Lluvia de Oro**, also in Chihuahua, is a property with rich quartz bunches occurring in limestone. It is proposed to float this mine in London; but here, again, the nature of the deposit is such that the purchase price should not amount to more than the value of the profit in sight, which is reported to be some hundred thousands sterling.

The **Cherokee (Mexican) Proprietary** is at the present time in an unsound condition, for lack of funds. My impression about this mine is that it has possibilities, and that it might repay the spending on it, in development, of a large sum. Of course, the present watered capital would have to be cut down drastically.

Finally, Mexico is as likely a country to produce new gold-mines as any I could name. All discoveries at present fall into the hands of Americans; but there seems room for several strong British organizations, who might be able in future to secure for us a fair share of whatever offered.

Central America. The list of gold-mines in Central America is not a long one. Of British companies there is the Butters' Salvador, Darien, Transito, Javali, and Aramecina.

Butters' Salvador has paid good profits for several years from a rich vein. The future, in depth, is reported to be doubtful.

Darien is also a small, rich mine which has paid well. Its ore-reserves are not large.

Transito is a large low-grade ore-deposit, located in Honduras. Indications at present are that this may become a payable mine.

The **Javali** is a low-grade mine in Nicaragua.

Aramecina is now shut down.

Much of Central America has a bad climate ; but there are also considerable areas which are healthy, and which are worth a more extended exploration than we have yet given to this part of the world.

South America. At the present time the whole of South America is estimated to produce not more gold than £2,500,000 sterling a year. This small amount is out of all proportion to the immense area, especially when one considers that the continuation of the great mountain chain, which in Alaska, Canada, the States, and Mexico, has produced so much gold, runs continuously from Colombia to Terra del Fuego.

It has, of course, to be borne in mind that from the days of the first Spaniards, who over three hundred years ago relieved the Incas of their hoards, an immense deal of gold has been found in South America. From Brazil alone the yield has probably been £100,000,000.

But the great bulk of South America's production has so far been alluvial gold. Assuming that such a vast territory carries the average proportion of payable quartz deposits, it may fairly be inferred that as yet most of these remain undiscovered ; and that, whereas in many other parts of the world gold is becoming worked out, we may look to South America for an increasing supply.

The drawbacks to economic mining in South America are considerable. The most serious are inefficient government, insecurity of title, and lack of means of communication. It may safely be said that it is because of these factors, and not for lack of gold, that the output remains at so small a figure.

At the present time Brazil is the biggest producer in South America, followed by Colombia and the Guianas. Chili, Peru, Venezuela, and Bolivia, produce moderately, but the yield from Ecuador, Argentina, Uruguay, and Paraguay is insignificant.

The chief producing quartz-mines are St. John del Rey, Ouro Preto and São Bento in Brazil ; Peters mine in British Guiana ; and

Frontino and Bolivia in Colombia. The greater part of the production still comes from alluvial ground.

The Ouro Preto district of the state of Minas Geraes, in Brazil, has been the most important quartz-mining field in South America; it is also the oldest gold-field in the New World, having been worked continuously for over two hundred years.

In this district is located the oldest British-owned gold-mine, Morro Velho, belonging to the **St. John del Rey** Company. This lode has been worked by the company since 1834, and has produced a vast deal of gold. The present depth of the lowest workings is 3700 feet, at which point the lode is still of payable value. The blocked-out reserves amount to about 800,000 tons. The average yield of the ore appears to be gradually getting less with depth; it is now about 40s. a long ton. There are 120 stamps, and the yearly output is about £290,000. Of late the profit has been seriously affected by the rate of exchange. The recent rise of the milreis in value from 1s. to 1s. 4d. means a loss equal to several shillings a ton, and must, while it lasts, seriously affect the profits.

This has been one of the most valuable ore-deposits in the history of gold-mining. The mine is well handled, but the prospects are not good at present.

In the same district is the Passagem mine of the **Ouro Preto** Company. This was worked as far back as 1817 on behalf of the Portuguese Government, and under various owners has produced a great deal of ore. The value at the present time is low-grade. There are eighty stamps, treating about 6000 tons a month; but while the rate of exchange remains so high, it seems unlikely that a profit can be earned.

Sao Bento is also in this district. It is a low-grade mine, treating about 4000 tons a month. The ore-reserves are increasing at present, but the high rate of exchange is likely to prevent profits being earned.

The Peters mine, in British Guiana, belonging to the **British**



ORE OUTCROP, PETERS MINE, BRITISH GUIANA



Guiana Gold Concessions Company of New York, is the most valuable quartz-mine discovered in South America of late years. Surface-workings have exposed a bluff of free-milling ore, and at a recent date 20,000 tons had been exposed. This is reported to run evenly in value, and to be worth at least £14 a ton.

The first report issued says "it is doubtful if there ever was so much valuable free-milling gold-ore uncovered with the same amount of work," and speaks of a "breast measuring 45 ft. in height, and up to 80 ft. horizontally."

Assuming that this report was drafted by a capable mine-valuer, and correctly states the quantity and value of ore so far exposed, this must be acknowledged as a wonderful find. The description of the deposit gives the idea that it is a bunch of ore rather than a defined reef, and may not live to much depth; but that is a question which will be answered by development work.

This discovery will draw attention to British Guiana, which hitherto has produced no quartz-mines of value. Its alluvial deposits, worked by natives, have yielded an average of over £300,000 a year for some time past. Unfortunately, much of the interior is unhealthy.

In French and Dutch Guiana there are large areas carrying alluvial gold, and the output is increasing. Gold-dredging here is expected to be successful, but the climate is bad. The **South American Goldfields Company** works placer mines in French territory, and in the Dutch colony the **Surinam Gold Concessions** is located.

In Venezuela there are now no producing mines of note. The **El Callao Consolidated** is a reconstruction of the once famous El Callao mine. I have seen a report by a Frenchman on this mine, stating that large quantities of payable ore remain, but in the absence of more definite evidence, am inclined to believe that the old owners, before abandoning either that mine or that district, had first assured themselves on this point.

On an island off the coast, the **Oruba Gold Concessions** is working.

twenty stamps, and is producing a small amount of gold. The ore-reserves are as yet small.

In Colombia the **Frontino & Bolivia** mine continues to produce, but has not made profits for some time past.

In Ecuador is the **Playa de Oro**, an English-owned mine, recently purchased from American holders.

Gold-mining in Peru is at present on a small scale. Some years ago the Santo Domingo mine, belonging to the **Inca Mining Company** of Philadelphia, in the southern part of the state, was making large returns. During 1902 the yield from the five-stamp mill at times exceeded £25,000 a month. I believe that this rich ore is now exhausted, and the mine is reported to be shut down.

This property is on the eastern slope of the Andes, and is reached, as to the last fifty miles, from the railway, by a bridle-path, which descends 14,000 ft. If the large masses of low-grade quartz which are reported to exist here, and to outcrop for many miles, are ever to be worked, it will be necessary, before anything else, to consider the problem of transport. To cut a waggon track down the face of the mountains would cost a very large sum, and to justify such expenditure a great deal of ore would first of all have to be exposed. Without such a track, a big low-grade mine, or mines, would hardly be able to work.

Another gold-mine on the eastern Andean slopes, but in the central part of Peru, is the **Chuquitambo**. This is a large deposit of conglomerate, which fills the space between two adjacent mountain spurs, at a height of 13,000 ft. This deposit is honey-combed with ancient workings, and it was evident to me, on inspection, that the old workers had taken out the richest patches. The whole area of the deposit appeared to be limited to about half a million tons, and the average value is probably not more than 12s. a ton.

A forty-stamp mill was erected, and during 1903-4 52,000 tons were milled, of a value of 12s. a ton, from which about 8s. a ton

was extracted. Working costs were small, but this figure barely paid expenses, and the mine is now shut down.

There are no other quartz-mines of note in South America.

It is evident, considering the disappointing outlook for gold-mining in Canada, Australia, New Zealand, Rhodesia, Mysore, and other established fields, both in and outside the empire, that the British, if they wish to maintain their preponderating hold of the gold-mining industry, must put a large share of the knowledge, energy, and capital available for this industry into the systematic search for new gold-fields. With this aim in view, South America, at the present juncture recommends itself to some of the best judges. The most desirable territories for exploration are those adjacent to the main mountain range, and to this I add my own belief that the eastern slopes of the Andes, little explored as they are, contain the potentialities of many rich gold-mines. Bolivia is known to be one of the richest mineral areas of the world. Peru, too, has a wonderful record. But as yet neither of these has been much explored on the eastern slopes. Add to these the as yet unknown areas of Brazil, Colombia, Ecuador, Argentina, and the Guianas, and a gigantic field for exploration opens itself up.

There are drawbacks to mining in South America, but it has, I think, to be recognized that the conditions are improving. Governments are unstable, but the tendency to revolution in the more progressive states is certainly diminishing; while even during revolutions foreign-owned mines have rarely suffered other loss than that of their labour supply. The fluctuation of the money-market is to-day a more serious factor than an unstable government; and the gold-mines in Brazil would, no doubt, choose a settled value for the milreis rather than the solid government of a British Colony. So far as I have been able to observe, the Governments of Chili, Peru, Bolivia, and Brazil, treat the foreign mining company fairly; while the methods of some provincial governments, such as that

of Minas Geraes, in Brazil, or San Juan, in Argentina, where mining is concerned, left on me a favourable impression.

But the best evidence under this head is the personal experience of those who have controlled mines like St. John del Rey, Ouro Preto, Frontino and Bolivia, Chuquitambo, Huanchaca, and Copiapo. I fancy their testimony would go to show that the misgovernment of South America, so far as their business is concerned, is not a determining factor.

A more serious phase of this question is the insecurity of title, which is rendered unsound in some of the countries by the unsatisfactory mining codes in use. This is where a corrupt official or government could do real harm if so minded, acting, too, in the spirit of the law. I would set a flawless title as absolutely the first requirement of any one who would deal with a mine or a prospect in South America.

As to means of communication, these can only improve for the better very gradually; and, no doubt because of this, much of the choicest mining country will remain unprospected for very many years.

Bolivia, of all countries, needs roads and railways, and it is satisfactory to know that here some improvement is taking place. The Central Northern Railway of the Argentine is now being continued into the south of Bolivia, and it seems probable that this will eventually junction with the line to Oruro, thus ensuring through rail communication between Buenos Ayres on the east coast, and Antofagasta on the Pacific.

At the present time, which, considering the necessity we are under of finding new gold-fields, is also a "psychological moment," evidence is being accumulated to show that South America may become a great centre for gold-dredging.

The genesis of the idea can be traced to New Zealand; the money for carrying it to fruition comes mainly from British residents in the Argentine.



R. SAN JUAN DE ORO, BOLIVIA



R. EWAN, TERRA DEL FUEGO

DREDGING AREAS IN SOUTH AMERICA

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The chief interest centres in the river San Juan de Oro, in Southern Bolivia, to dredge which a concession was given by the Government to an Englishman in Buenos Ayres.

This river, with its tributaries, is said to carry a dredgable area equal to the whole of such ground in New Zealand and Australia.

From the concession some six or seven areas have been floated off as separate concerns. One of these is owned in Manchester, the rest in Buenos Ayres. The great bulk of the ground—still the property of the concessionaire—has been placed in the hands of a South African house, and, if of value, will be financed by it.

Dredging experts from New Zealand have reported on parts of this ground, and are now retained to build and manage the dredges which the companies are erecting. The reports of these men state that such ground as they examined is not only more suitable for dredging, but is richer than the best areas of the Otago rivers, and they have stated privately that they look for astounding results. The evidence of actual prospecting, which accompanies their report, is meagre; but it is stated that since these reports were made further prospecting work has more than justified the opinions then formed.

As to facilities, these are excellent. Within two years the Central Northern Argentine Railway, now being extended into Bolivia, will reach the locality. There is good labour on the spot. The climate is healthy, and the mining laws of Bolivia, both as to title and tenure, are considered sound. Wood fuel is not too plentiful, but either gas-engines or oil can be used.

As regards the peculiar requirements of dredging-ground, the San Juan de Oro appears to approach the ideal. The conformation of the river lends itself to concentration of values. The gravel is deep, free from large boulders and tree-roots, and the bed-rock is a soft bed or false bottom of clay. There is neither too much nor too little water in the river, the current is not fast, floods are exceptional, and there is no ice. If to this only be added payable gold, one-fifth as rich as the trial bores showed, a great industry will spring up in

Bolivia. This is only one of many rivers on the eastern Andean slopes.

The companies already formed on the San Juan are the **Rio San Juan de Oro**, with office in Manchester, and the **Second, Third, Fourth, and Fifth Rio San Juan de Oro, Gran Venero, and Sucre**, with offices in Buenos Ayres. Lower down the river is the ground of the **Pilaya** Company of Edinburgh; but the suitability of this for dredging, owing to the deepness of the gravel is not yet demonstrated.

While these facts with regard to dredging in Bolivia were becoming known, other individuals were acquiring knowledge about the rivers of the **Matto Grosso** district, in the far interior of Brazil. Some years ago a concession over some of this ground was floated at Charters Towers, in Queensland, and the materials for a dredge were sent up the Parana River and erected. This ground and dredge is now the property of the **Matto Grosso** Company of Buenos Ayres. The dredge has worked for some time, and has demonstrated that there is payable gold. It has also demonstrated the existence of diamonds in the gravel, for a number have been caught on the tables.

A number of companies have now been floated in Buenos Ayres to dredge in Matto Grosso. In the prospectus of these due justice has been done to the presence of diamonds as well as gold. In one, lying before me, a German engineer shows a yearly profit on the working of two dredges of £170,000, of which one-third is to come from gold, and the rest from diamonds. He omits to state how the diamonds are to be recovered. It is possible that in Matto Grosso, or elsewhere in Brazil, the quantity of diamonds in the river gravels is appreciable; but before these can be reckoned as of economic value, a method for saving them must be evolved.

The Matto Grosso district, setting aside the diamonds, will no doubt be found to carry payable dredging ground in many places,

and the aggregate of such payable places will be probably great. But, economically, I do not rank Matto Grosso with San Juan. The Bolivian field will soon be connected with a railway ; whereas the most accessible parts of Matto Grosso are a three weeks' journey up the Parana River system, and communication is unreliable. As to security, I would place the Bolivian title higher than that of the Matto Grosso State. For general facilities the San Juan district, except as to fuel, must be far ahead.

The day for Matto Grosso will come, no doubt ; but very many economic problems must first be determined, and the immediate flotation of dredging concessions there is not justified.

Elsewhere in Brazil, in Para probably, and notably in Minas Geraes, there appears to be material for a big dredging industry. I inspected the newly erected dredge of the **Rio das Mortes** Company of Napier, New Zealand, at work near the old mining town of St. João del Rey. Here conditions are favourable, and with an expected recovery of 5d. a cubic yard, good profits should be earned.

The wonderful results of prospecting the San Juan de Oro ; the favourable reports of the New Zealanders ; the gold and diamonds of Matto Grosso ; and the plethora of money in Buenos Ayres, due to several good seasons ;—led to an outburst of speculation in dredging companies. The Bolivian shares went to big premiums, as did those of the several Matto Grosso concerns. Before long flotations of ground in Chili, Terra del Fuego, and in the Argentine, were made. Some of these appear to have a doubtful title, and in others the value of the ground itself is in question. All are probably over-capitalized, for where a dredge in New Zealand pays a fair dividend on a capital of £15,000, the Buenos Ayres spectator looks for the same return on a capital from ten to twenty times as great.

That many of these concerns will eventually earn some profit, I believe ; but the empiric method of capitalization, which places the shares at a premium before the dredge begins to work, is a somewhat dangerous method for these lay speculators of the Argentine.

Terra del Fuego is a territory which, next to San Juan de Oro and Matto Grosso, has received most attention as a dredging field. For a number of years a colony of alluvial miners have done well there—on the Chilian side—and evidence goes to show that there is likely to be some payable dredging country. Where richest the ground is heavy for dredging, and will require the strongest type of machine to make a success. The **Sutphen** and **Rio Oscar** Companies, of Buenos Ayres, have been formed to work this ground.

On the Argentine side the ground is, as a rule, more adapted to dredging, but not so rich.

There is some doubt in the Argentine, both as to ground in Terra del Fuego, Patagonia, and the Argentine proper, as to whether, in strict interpretation of the mining law, satisfactory title can be secured over a large dredging area. Legal authorities say it cannot. Under the circumstances it would be judicious for the Argentine Minister of Mines to have the issue put beyond doubt.

Besides Bolivia, Brazil, Chili, and Argentina, it is probable that a dredging industry will spring up in the Guianas and Peru. In the latter country a British syndicate has secured a concession of some hundreds of miles of river. Parts of this have been reported on, and very high values are vouched for. The location of this ground—on the Eastern Andean slope—is a serious factor; the whole material for the dredges will have to be carried down the mountain track of the Santo Domingo mine, already referred to. Building a dredge out of sections small enough to be carried on a mule's back—whereas the normal dredge uses castings up to two and a half tons weight—must tend to weaken it, and to throw doubt on its efficiency in heavy ground. However, the experiment will shortly be made, and it may be that this Peruvian river will turn out to be one of the richest dredging areas in South America.

CHAPTER XV

THE GOLD-MINES OF MOZAMBIQUE, WEST AFRICA, EGYPT,
SUDAN, HUNGARY, BOHEMIA, WALES, ETC.

THE gold-fields yet to be described are those of Africa, other than the Transvaal and Rhodesia, and those of Europe, other than Russia.

Mozambique. In this large territory, notably in the Manica-land district, there is evidence of a considerable gold-bearing area. So far as can be seen, the characteristics of the deposits are similar to those in Rhodesia, of whose mineralized belt Mozambique is the natural extension.

The mines floated in the Manica district have so far shown the typical Rhodesian characteristics; that is to say, smallish veins, short ore chutes, and loss of values at a moderate depth.

Among such mines have been the **Manica Development Syndicate**, **Mozambique Macequece**, and **Revue**. The last-named developed a certain quantity of payable ore before going wrong in depth, which is now being crushed with a small mill; but there are no future prospects.

In the Manica district gold-dredging has also been tried. So far it has been a failure, due, probably, as much to injudiciously selected areas as to lack of gold.

The unhealthy climate of Mozambique is a factor which retards its development.

The Island of **Madagascar** has so far produced no gold-reefs; this in spite of the fact that since 1890 there have been continual

rumours of rich discoveries. There is no reason why quartz-mines should not exist there, however. There is alluvial gold, and the natives wash this to a considerable extent.

My inquiries were limited to the coast towns; but an engineer who spent six months inland, prospecting, was disillusioned. The gravels he tested for dredging were all too poor, and he heard of no payable quartz.

The French, who are in the throes of a gold boom in Madagascar, have made some recent discoveries. So far as exposed, several of these seem good, but they ought to make sure of the values at depth before committing themselves too greatly. The Government imposes a tax of 5 per cent on the gross output of gold, but an increased tax is now suggested.

West Africa. There is so much to be said against the gold-mining industry in West Africa that I should like, at the same time, to say something in its favour; but I cannot think of anything. To say that there is a lot of gold is true; but if this, as is most evident, is rarely or never so concentrated as to be of economic value, where is the advantage?

I cannot name one mine in West Africa that will certainly pay; that is to say, will return the money sunk in it with fair interest. There may be such mines in the country, but they have not yet shown themselves.

Possibly the real benefit from this field, if there is eventually to be a benefit, may come in after years, when the country shall have been more opened up, the conditions ameliorated, and yet undiscovered mines of value brought to light.

The climate of this country is deadly; sophistry cannot explain it away, and for many years to come it must act as a determining factor on the fortunes of the mining industry.

Considerations of health do not, as a rule, frighten Britishers away when a country has to be opened up. As the result of the pioneering work now being done, wherein the lives of many have been, and are being, sacrificed, West Africa may one day become

a more habitable country. This is, indeed, a probability. But this criticism is not written for the eyes of the next generation. What I am concerned with is the value of this gold-field for, say, the next ten years, and I can only say that, as conditions are at present, the climate is deadly.

This factor is all-embracing. Firstly, it is to be noted that, as a rule, the best men—men of high administrative and scientific acquirements—will not go to the West African mines to live. The speculator, in the flush of a boom, perhaps thinks nothing of a thing like this; but the reflective person will understand that in mining, as in most other things, the lack of the best brains and skill in the long run have a serious effect.

But if only a minority of the men who go there—whether as managers or members of the staff—are average or superior people, a majority must be below the average. This deficiency may take the form of weakness in character, incapacity for good work, or it may be a complete lack of experience. To this natural deficiency of one sort or another has to be added these effects of the climate, debilitating such men still further both physically and morally.

Assuming even that a good manager and staff have been got together on a West African mine, does that mine receive full benefit from such? It does not; for every year the whole staff, in relays, must leave the country for considerable periods to recuperate; and this lack of continuity in policy, whether it be the manager's or that of any of the important departments, is not the least of the evils due to the climate.

Then take note of another aspect. When it comes to the all-important business of mine-valuation, especially as regards mines in a new field, it is usual that the final estimates be not come to by one man, however capable he be, but that they shall be checked or revised at the hands of probably half-a-dozen experienced valuers. These men, too, have to do their work in the glare of day. If they err gravely, whether knowingly or not, their fault is soon evident to the professional world, and they become discredited.

But in West Africa, what sort of check is there on a man? There

is none at all. It is admitted that the average man on this field is lacking in some essential or other. With the best intentions in the world these men, as a body, ought not to have thrown on them the full responsibility of mine-valuation. The work of samplers, assayers, and surveyors, and the final estimates of the managers ought, for the sake of reasonable precaution, to be checked. But who is going to do this? Where are the men of pre-eminent standing who will weigh these results in the light of their greater experience, and when they see errors use their prestige in the mining world in having them rectified.

It has to be admitted that these men are not there, and that this court of professional appeal, which is so needful to the right conduct of gold-mining, is not known in the country. It cannot be remedied, unfortunately. The thoughtful person will, however, take note of the situation of affairs. He will see that the managers, who must often be inexperienced in mine-valuation, have, in this vital matter, to take on themselves far more responsibility than more experienced mine-valuers in healthier climates.

Now add to this the psychological aspect. These men who may be of unformed character, perhaps eager to retrieve professional or financial failure elsewhere, or young, anxious to please in their first managements, are brought face to face with the great problem of mine-valuation. Are they to assert their own personalities, or do nothing, and let the course of events solve the problem for them? They know that their directors have heavy interests in the mines; that the price of the shares in London is the present criterion of success; and that emphasis of the optimistic side of the question will please their employers.

I do not want to censure indiscriminately, but rather draw attention to the difficult circumstances in which these men are placed.

But it has to be admitted that many of them have drifted along the line of least resistance. Whether it was due to pressure from London, or to their anxiety to please those in authority, or to their lack of judgment, or to their ignorance of the basis of sound

valuation, they allowed the true economic value of this gold-field to be for years wrapped in mystery, from which it is now emerging discredited.

In most cases a clearly unjustifiable opinion about the mines' capabilities has been in circulation. The finding, in many cases, of a greater or less amount of payable ore ought not to have warped a manager's judgment to a disregard of the economic drawbacks, which must have been visible to the meanest intelligence.

The net result seems to be that a series of ore-patches—many of them rich, but nearly all of them of insufficient area commercially—have been magnified into mines. For this state of affairs, from a professional point of view, the managers of these, collectively, are not to be held blameless.

Of the three classes of mining venture embarked on in West Africa—the banket-ore of the Wassau district, the quartz-reefs of Ashanti and elsewhere, and the dredging for gold in some of the rivers—the latter seems, if anything, the more hopeful; it is possible that some of the dredging concerns may earn profits.

These dredging companies are the **Offin River**, **Birim Valley**, **Ashanti Gold-fields Auxiliary**, and **African Gold Dredging**. Several of these have had prospecting dredges at work for some time, and have evidently some good ground; as to whether the areas already tested are of the average value, or better than the average, is a point which those in control should make clear.

The banket bed of the Wassau district, worked in a small way since 1882, has been shown to lack the regularity of the Rand beds; in another respect, too—the amount of ore in a given area—it is at a disadvantage. No real comparison between the two fields is possible. Whereas the Rand beds carry their width and their value over great areas, both in length and depth, it is doubtful whether at Wassau the length of payable ore extends, at the surface, through more than two or three mines, while in depth, even moderate depth, it is feared that it goes badly wrong.

The best chute of ore seems to be that in the **Wassau** mine ; but it is a small reef, and working costs are high. The good ore, too, seems plainly limited to one section of the mine, and the ore-reserves are out of all proportion to the capital of the concern.

The prospects of the **Abosso** and **Abbontiakoon** mines perhaps rank next in order.

The other mines on this line seem still less favourably situated. Probably if the whole of them were amalgamated into one, and the payable patches worked, a fairly large mill could be run, and the expenses brought down to a reasonable figure. A lot of little mills, with economic conditions such as they are, will eat up the profits that might perhaps be available.

The West African quartz-mines, so far as can now be seen, look to be mostly lenses of ore, and as to whether in depth these will be replaced by other lenses is in a number of cases somewhat speculative. But even assuming depth for the ore, do the values continue down? So far, the prevailing characteristic has been a rich outcrop, a hopeful outlook for perhaps a couple of hundred feet, and then a steady diminution in gold contents.

Even among the mines which at one time or another, to judge from their yield of gold, have had some hope of living down, this characteristic shows itself. The several **Ashanti Goldfields** mines, **Ashanti Sansu**, and **Bibiani**—are properties that occur to one at present ; and two years hence the list will be longer.

On their small ore-reserves most of these mines should never have erected mills ; indeed, the waste of money on machinery—a pandering to the exigencies of the Stock Exchange—has been the curse of all our gold-fields. Probably the erection of about five judiciously placed mills would satisfy the economic requirements of the whole of West Africa ; while an amalgamation of the mines that have any real value into about five consolidations would also be a justifiable programme.

Among the quartz-mines which have some payable ore developed

are **Akrokerri**, **Broomassie**, **Prestea Block A**, **Ashanti Goldfields**, and **Bibiani**; but in the case of these and other mines there is yet no evidence of permanence.

Egypt and the Sudan. A great area of country, consisting of Upper Egypt and the Northern Sudan, or, rather, such parts of them as lie between the Nile and the Red Sea, has been divided up into government mining concessions, and is now in process of being explored and prospected. Although relatively little work has yet been done—for the greater part of the whole area is waterless desert—the existence of gold-reefs has been proved in a number of spots.

As in Rhodesia, and elsewhere, the location of these reefs is determined by the existence of ancient workings, and evidence has accumulated to show that these are widely spread. Such workings do not necessarily indicate a payable reef; indeed, in most cases, one would find that the reef would not be payable. This old work was done by slave labour, and after providing for the cost of food to the workers, all the gold recovered was profit. Even in the crude mills for hand-grinding the ore, quantities of which are seen lying near the old workings, a ton of ore yielding 20s. probably gave some profit; whereas, under modern conditions, similarly located ore will cost more to handle.

The evidences of gold in Egypt and the Sudan are good enough to warrant the spending of a lot of money in exploration work. I advocate this on general rather than particular lines; for many of our older fields are coming to an end, and to make good their loss all parts of the Empire, where there is any chance at all, should be explored.

On the other hand, no really sound mine, no mine of permanence, has yet been found, and there is nothing to justify large capitalizations. There is no reason why this should not become in time a successful field, but it should be understood that up to the present the discoveries have been of minor importance.

Some of the economic conditions of this field are good, others bad. Government, of course, is stable, and the concessions have been granted on reasonable terms. The mines department in Cairo will be found ready to discuss fairly all matters of policy.

The climate is fine. Labour is cheap and on the whole excellent.

As against these facilities, there is usually a scarcity of water; while such water as may be procurable is apt to be unfit either for drinking or for milling with.

Timber, fuel, and stores, have to be brought from a distance, while transport is slow, and for heavy machinery is difficult to arrange at all.

I take it that no mine of any size, requiring big machinery in the first place, and regular supplies of fuel, timber, and stores, thereafter, will be able to work independent of railway communication. The cost of a light line connecting up the mine with either the Wady Halfa-Khartum or Suakin-Berber railways will have to figure in the estimates; should the mine be 100 miles from a railway, this cost will be a serious one.

Although the climate of the country is fine, the mine-valuer will take due note of the depressing effect of the desert wastes upon one's system. In the desert, too, things move with deathly slowness. Your pack-camel makes a bare two-and-a-half miles an hour, and your Arab labourer is not to be cajoled into any real state of energy. The sands hide their secrets well; what is found will literally have to be dragged from beneath their covering. The prospector here has a hard and dreary task before him.

On the whole, I would sum up the working facilities, once the mine has been developed, as not too unfavourable; some countries are not so good. If the mines can afford the cost of direct rail communication, some of the worst factors would disappear. No doubt, over a large area, perhaps over more than one-half of the whole, the lack of water will prevent even any exploration. Before money is spent on definite prospecting, the existence of a good water supply should be demonstrated.



A PROSPECTING SHAFT IN THE SUDAN

The work done on this vast field, so far, is relatively little. But a characteristic of the mines located or opened up is certainly a narrowness of reef. At the Nile Valley the average width is placed at two feet. At Um Rus it is about one foot. At Um Nabardi, the most developed mine in the Sudan, I judged it to be less than this. At Um Gabait, belonging to the Sudan mines, the average measurement is twenty inches.

This is not conclusive evidence as to the whole field ; but it is a bad feature that some of the hitherto most actively developed mines should show so poorly in this respect.

Where the reef is narrow, the ore-chute is liable to be short, and the persistence of the lode to considerable depth would be a debatable point. A mine of these dimensions would run only five or ten stamps, and the ore exposed at any given time would be on a corresponding scale. In any case, a five or ten stamp mine, however rich, is but a hand-to-mouth affair, expensive to run, and uncertain for a year ahead. Such a property cannot possibly stand the big capital with which these Egyptian and Sudan companies are coming into being.

As to the persistence, or otherwise, of these small lodes in depth, it is early yet to speak. I doubt whether any of them can possibly last long enough, and produce enough ore, to pay material profits, or that any of those yet found will be able to pay £1 a share on their capital.

These mines are of rather high value, so far as they go ; possibly the average of ore exposed up to the present is £6 a ton. But the small mine is no good in the long run. When this field can show some reefs 6 ft. to 10 ft. wide, and worth £2 to £2 10s. per ton, I shall think more of its prospects than I do now.

The **Um Rus** mine, some 300 miles south of Suez, is close to the Red Sea littoral, and has, therefore, no transport problem to solve. The lode has been proved to, I believe, 500 ft. on the incline, but the width is small ; the length of the ore-chute is not as yet proved to be unusual.

The **Nile Valley** is a mine of rich pockets—a disappointing type, as a rule. Excepting these pockets, the average value is not excessive, and the permanence in depth, both of ore and values, has still to be proved. The reserves are small. Other ore-deposits are known to exist on the concession.

Nile Valley Block E. The value of the reef has not yet been proved. The company also owns a concession in the Sudan.

North Nile Valley is an offshoot of the Nile Valley Company. The value of the ground is doubtful, although some gold has been found.

The **Fatira** and **Eridia** mines, in Upper Egypt, show doubtful values as yet.

The Um Nabardi mine of the **Sudan Gold Field** Company is a rich vein, though less than a foot wide. The mine is connected with the Wady Halfa railway by a light line thirty miles long. This had to be built before pumping and hauling machinery for exploratory work could be taken in. Elsewhere a railway is the finishing touch, added only when the future of the mine seems assured; in the Sudan a railway comes first, to ensure transport, and is not the sign of certainty.

As the water at Um Nabardi is unfit for milling with, it is intended, should the mine develop well, to erect a mill on the Nile, 150 miles distant, and carry the ore there at an extra cost of probably 6s. a ton.

In the case of this mine the difficulties due to lack of transport and distance from water are clearly shown.

The Um Gabait and Wady Oi reefs of the **Sudan Mines** have some ore exposed, but are badly situated as regards water.

The problem of exploring and opening mines in Upper Egypt and the Sudan is not a light one to face; the initial difficulties to be overcome are many and serious. The men who are engaged on this work deserve due recognition of their services.

Gold is known to be in Abyssinia. There is a native industry, and in due time mines will be found, and pass into the hands of foreigners. As is usual with countries not accessible, the rumours of rich mines are altogether wide of the mark.

An Italian company, the **Societa Eritrea**, is opening a mine in the colony of Erythrea.

Elsewhere in Africa there are as yet no gold-mines known. A little alluvial gold comes from the Congo, but there is none in Central Africa. Some finds are reported from German East Africa, but the value of these is in doubt. Some years ago finds of gold were reported from Tunis; these, too, are doubtful.

There is gold in Morocco. A friend of mine, who lived for some years with the Sultan, told me that supplies of gold were forwarded to him from workings in the Atlas Mountains. These arrived melted down into little bars.

Hungary. In Europe, outside of Russia, the only country turning out much gold is Hungary. The yield from there is still nearly £400,000 a year; and the Romans mined in that country 2000 years ago. Hungary has probably been one of the richest gold-fields in the world.

Most of the mines are in Transylvania. No concise statement of the work done is, however, possible, as the industry is mainly in the hands of the Hungarians themselves, and small individual producers are responsible for the greater part of the yield.

So far as my observations went, I should say there are not many mines left in Hungary that are worth buying. The bigger deposits at the present time show either spotty or very low-grade values while as for the rich telluride veins, these may yield profits to the individual, but certainly not to a large organization. This is borne out by the fate of both German and British companies which have taken over Hungarian mines of late years. These have mostly been unsuccessful. One British-owned mine, the **Rota Anna**, worked

with sixty stamps, but is now shut down. Another, the **Tekorö**, which I inspected—a big mass of low-grade pyrites—also ran at a loss.

It would, of course, be unwarranted to assume that all Hungarian ventures are unsafe; but unless the ore is actually exposed I would feel somewhat sceptical of results.

There is one interesting mine, certainly, which may be worth buying and running on modern lines. This is **Nadyag**, largely owned by members of the Royal Family, and worked continuously for some hundreds of years.

The mine is composed of a network of telluride veins, which have been worked through a series of adits to a great depth. These veins of telluride are often no more than the thickness of a knife-edge. The past method of mining has been to hand-sort these streaks from the mass of rock broken down, and to smelt the product, and on this basis the amount of rich ore produced was limited to perhaps several tons a month. On each side of the veins, for several feet, the rock carries some value—which decreases gradually, and there are dumps of this rejected rock, averaging, it is thought, between 15s. and 20s. a ton, to the extent of many million tons. This ore carries much mineral and is difficult to handle from a metallurgical point of view.

In the mine there is also known to be a great amount of this lower-grade ore exposed, much of which is fully developed, and can be stripped down with small expense. If not too great a width were mined, much of this would assay over 30s. a ton. Provided an effective process to extract the values can be found, there is probably still in this mine the making of a successful low-grade venture.

The show mine of Hungary is the "Twelve Apostles," belonging to the **Harkort'sche** Company, of Gotha. This is a purely German venture, both as to capital, machinery, and management, and is the only gold-mine I know of that is. Its record does the Germans credit. Several reefs are in the mine. These have been for a number of years, to a considerable depth, and the val

signs of deterioration. When I inspected this mine, some years ago, the recovery value of the ore had fallen to about 19s. a ton, and the costs were about 12s. a ton.

The underground work was excellent. This is done by Italians and Roumanians—the average rate of pay being less than 2s. a day. About 13,000 tons are mined monthly. The ore is taken through an adit a mile long, by an electric railway. From the mouth of the tunnel an aerial tram carries it to the battery. There are 185 light stamps, and concentrating tables; the tailings are not cyanided. The mill and machinery are very fine; indeed, the machinery-room on this mine was a revelation to me. I had not known that so completely equipped a gold-mine existed in Europe. As regards profits, the “Twelve Apostles” mine has probably passed its best days; but its management and equipment are quite good.

At Verespatak is a mountain of ore, worked in the days of the Romans. If the sides of the great caverns they excavated are systematically sampled, it will be found that the ore on their walls assays, on an average, perhaps 5s. a ton. It is evident that great quantities of the ore mined here in those days was of the lowest value, and with their primitive methods of breaking down and crushing, the return per man engaged must have been infinitesimal. This is another argument that in earlier days gold-mining was done by means of slave-labour, and that the presence of ancient workings does not necessarily connote the existence of payable reefs.

In the neighbourhood of this mountain hundreds of miners still make a living. Their small mills of wooden stamps, aggregating some thousands, driven by water-wheels, and attended to by their women-folk, crowd the valley for some miles.

In Bohemia I inspected the **Mount Roudny** mine—the only gold-mine, I believe, in that country. There are four lodes in this mine, which at one end converge, and form a deposit in places 60 ft. wide. The ore is patchy. Some is rich, but the average is certainly low-grade. At the time of my examination, there was no quantity of ore

exposed which would yield as much as 30s. a ton. I judged the mine to be worth further development, but on its then ore-reserves could not attach much value to it. Large ancient workings are visible on the surface. The facilities for cheap working are favourable.

In Servia there is now gold-dredging. It is probable that this will yield some profit.

In Italy there are several small mines, with ten-stamp equipments. These are the **Rimella**, **Evancon**, and **Antrona**.

The present gold yield of Spain, Norway, and Turkey, is trifling. Most of the European countries produce no gold at all.

In Wales, the **St. David's** mine is at present a relatively large gold-producer. It is, however, a patchy ore, and one would not be justified in assuming much a foot ahead of the actual developments.

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